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I. THE NATURAL HISTORY OF PRATAS ISLAND, IN THE CHINA SEA.

By Dr. Cuthbert Collingwood,* Naturalist on board of H.M.S. 'Serpent.'

Pratas Island is situated in lat. 20° 42′ N., and long. 116° 43′ E., and is of a horse-shoe shape, occupying the centre of the sunken or western part of the great Pratas reef. The reef itself is of a crescentic form, extending 13 miles to the eastward, and having a breadth from north to south of 12 miles, encloses a lagoon of about 10 miles in diameter, dotted over with numberless coral patches and shoals. It lies in the direct line of route between Manilla and Hong Kong, and is therefore a spot where many a good ship has been wrecked, especially upon its south-eastern side, which is too often concealed by the thick fogs which prevail during the N.E. monsoon. The Pratas reef and island were surveyed by H.M.S. 'Saracen,' J. Richards master commanding, in 1858, and at that time it was believed that vessels of 15 feet draught could enter the lagoon by the south channel, between the south side of the island and the south-west horn of the reef, but in our recent visit in H.M.S. 'Serpent,' Commander Bullock found that although only drawing 12½ feet, she could not safely make the attempt, to my great disappointment, and consequently she was anchored on the edge of the reef, 3 miles south of the island, which thus sheltered the ship from the strong N.E. wind blowing at the time.

Pratas Island is about a mile and a half long, and half-a-mile wide, and is only visible at a distance of 8 or 9 miles in clear

* It may be interesting to our readers to know that the author of the above article gave up his occupations in Liverpool about a year since, and volunteered as naturalist on board one of H.M.'s surveying ships in the China Seas.

His friends will be glad to hear that in December last he was at Singapore, from which place he sent us the present article, and was about to proceed to Labuan, Sarawak, &c.—The Editors.

weather; not rising in its highest part more than 25 or 30 feet above the level of the sea, though the bushes which cover some parts give it an additional elevation of 10 feet or so.

On Monday morning, April 30th last, Capt. Bullock and I, with Mr. Sutton, chief engineer of the 'Serpent,' visited the island, two hours' pull from the ship, and I spent the whole day in exploring its character and natural history features. It is formed entirely of coarse coral-sand or débris, generally shelving gradually, but in some parts having a steep bank about 3 feet high. The interior is rough and hilly, from accumulations of similar white sand blown up from the shore, and so overgrown is it with shrubs as to be in some parts almost impenetrable, though the soil might be supposed to be anything but favourable to vegetable growth, nothing but sand being anywhere visible, and that of the coarsest and loosest description. The bushes in some places approach very near the sea, and between them and the water's edge various flowers not unfrequently peep out from the inhospitable soil, including a potentilla, an anemone, a plantago, and some grasses. On the west side of the island is a deep indentation into which the sea enters, forming a shallow lagoon or bay, on the banks of which the vegetation assumes quite a park-like aspect; bushes, and even small trees, with spreading branches springing forth close to the ground, producing a scene of great luxuriance and some beauty. Amongst the bushes immense orthopterous insects (grasshoppers) flew about, exhibiting a deep-red underwing, and looking very much like small birds. To the shrubs also were attached numerous geometric webs, which were occupied by a species of spider belonging to the division *Acrosoma*, having a squarish abdomen, from the upper surface of which projected several spike-like processes. This was the only species of spider which came under my notice; and in its web there appeared to be as often another spider of the same species as any other kind of insect, the paucity of insect life on the island apparently driving them to cannibalism. A moth, whose expanse of wing was about an inch, and having small red and black spots upon the wing, was pretty numerous, and appeared to be the only lepidopterous insect, with the exception of a large clear-winged species, which was captured, but unfortunately escaped again. These, with some ants and a few carrion beetles, constituted the insect fauna, as far as could be determined during our single visit.

Among the coral-débris upon the beach, were numerous masses of various sizes, consisting of rolled Astræas, Madrepores, &c.; and mingled with them were fragments of shells of a great many species of Conus, Cypræa, Turbo, Pinna, Hippopus, &c.; but none of them entire. Innumerable little Hermits (Paguri and Cænobitæ) occupied the deserted shells of Naticæ and Neritinæ, and larger ones those of good-sized Turbines; but I saw no live shells upon the beach,

except a few insignificant ones, such as Litorinæ and Purpuræ; nor, though the water was bright and clear, and I waded out as far as I could go, could I anywhere see any traces of Annelids or Echinoderms. The harder parts of the sand were harrowed with deep holes of various sizes, from which emerged from time to time a wary and swift-footed crab (Ocypoda), which scuttled nimbly down to the sea upon the first sign of approaching footsteps, and appeared to be aware of us at least at 50 yards distance. Nor was it easy to capture a specimen, for while on the one hand they never made the mistake of running *away from* the sea, on the other hand, if cut off, they fled so quickly, and *doubled* so nimbly, suddenly running the opposite way without the clumsy process of turning round, that they afforded great amusement and not a little exercise and exertion.

The sea in the neighbourhood of the Pratas Island has a very variegated appearance, from the alternations of bare white sandy bottom, with patches of Ulva and Zostera, both of which are very abundant. The Ulva is a very beautiful reticulated species, and the Zostera leaves float about in all directions and in all stages of decay, generally bearing upon them minute dendritic polyzoa, lunulites, spirorbis, &c., with which the towing-net from the ship was replenished. Besides the Ulva, I obtained several other species of seaweed, washed up on the beach, and conspicuous among them a species of Padina, very abundant everywhere in these seas, and a Sargassum.

As might be expected on so small an island, quadrupeds are scarce, nor did we observe any, though it is said the universal Rat was seen there when the 'Dove' visited the spot, nor did I notice the bones of any quadrupeds which would have indicated their existence there. The skeletons of turtle I met with more than once, but whether they visit the island, or are cast up dead upon the beach, I am unable to say. No other traces of reptiles were observed.

Pratas Island is occasionally visited by Chinese fishermen, who repair to it in the early part of the year, and there is a good junk-anchorage in the N.E. corner of the lagoon. We soon came upon traces of such a visit in a clear patch among the scrub, in the midst of which a well had been sunk, from which brackish water might be obtained. There were scattered about various implements of pottery, in the shape of water-vessels and teapots, some entire and others more or less broken, and surrounding them were strewed great numbers of shells, of a species of Strombus, the remnants of a past feast, and which remained to form a future kitchen-midden in the sand. At the head of the shallow inlet or lagoon stood a joss-house, or Chinese temple, in a rather dilapidated condition from the effects of wind and weather, the roof nearly torn off, and the

plank walls very shaky, so that the rain and weather had left their visible traces also upon the contents and furniture. In this rough building were 30 or 40 josses, or wooden idols, of various sizes, once resplendent in paint and gilding, but now faded and weather-worn. They were arranged symmetrically upon a sort of altar, and upon the tables before them were bundles of joss-sticks, packets of joss-papers, rouleaux of paper dollars, lucky stones, gongs, tom-toms, while around the building were grotesque wood carvings, procession staves, and all the paraphernalia of the Chinese devil-propitiators. We soon found, however, that they must be handled with caution—they were rotting with damp and decay, and harboured numbers of small scorpions, white ants, and ugly-looking spiders, which commanded a certain amount of respect from their malignant and venomous appearance. The blue-jackets especially, with their bare feet, were very shy of walking about in a spot where scorpions had their habitation, but fortunately no one suffered from their stings. Among other offerings to Joss, were a number of large model-ships, representing three-deckers, and made of paper stretched upon frames of wood, now much torn and dilapidated, but which showed plainly the piratical tendencies of the frequenters of the temple, and their desire that Joss should cast some barbarian ships upon the shore for them to plunder. As far as we could judge, however, from the condition of the place, it must have been three or four months since anyone had visited the island.

A slope of long, rank grass led down from the joss-house to the shores of the shallow inlet, upon which, and in the water, were strewed immense numbers of dead shells of Cerithium, some few of which were inhabited by hermit crabs. From observations made at the island upon the tide, it appeared that during the day of full moon it was high water at 8 a.m., and ebbed until 3.15 p.m., by which time it had fallen 3 feet. It was not surprising, therefore, that some of these deserted shells were high and dry, but this would hardly account for the fact that, considerably above high-water mark, many lay half-embedded in the dried mud and thick confirmed growth which had long lain above high-water mark, and bore the signs of having been well baked and cracked by many a noonday sun. The banks of the lagoon had evidently been under water comparatively recently, and much higher up than the tide now reached.

But although some classes of animals were poorly represented upon Pratas Island, there were plenty of birds, and of several species, both sea and land birds. A buzzard I noticed several times, but it was too wary to allow me to come within gunshot, although it offered a tantalizing mark just out of range. I observed a very handsome shrike, with an ash-coloured head and

black moustache. The blue-jackets reported that they had seen a canary, and I afterwards saw myself a yellowish bird resembling the English Siskin, which was probably the bird they had noticed. Another bird, about the size of a blackbird, was of a glossy metallic blue above and fawn-coloured beneath. Its stomach contained the elytra of beetles. A fifth species presented all the appearance of a veritable blackbird, but I could not get near enough to examine it closely. A species of swallow, with glossy bluish back, chestnut neck, and with a speckled fawn-colour underneath, was flying about in considerable numbers; and on the banks of the shallow inlet I saw a bright-coloured kingfisher, very similar in appearance and size to our own species. There were also some small birds which crossed our path from time to time, with the jerking flight and the chirrup of the hard-billed passeres. Large flocks of Tringas (sandpipers), of at least two species, were visible on the sandy flats of the inlet which were left uncovered in the afternoon, and also upon some parts of the seaward shore of the island, where it was inclined to be soft and marshy. There were also two species of plover, the one of a reddish-brown colour, with orange-red legs; the other of a delicate mouse colour, with yellow legs; and a godwit (Limosa), speckled grey and brown, with greenish legs and a recurved beak. A large rapacious-looking bird, which came sailing majestically within gunshot, was brought down, and turned out to be the frigate bird (Tachypetes aquilus), a bird confined to tropical regions, but having a wide range throughout them, being not uncommon both in the Atlantic and Pacific Oceans. When it fell, a strong guano-like smell pervaded it, which was very disagreeable. I measured its expanse of wing, which proved to be nearly 7 feet from tip to tip; and on opening its stomach I found, in a partially digested state, three large flying fishes and two squids. Small flocks of a pretty species of white egret frequently flew along the shore, and indeed, with gannets, made their appearance about the ship immediately upon her anchoring off the shoal. I shot one from the ship for examination, and found it to be 20 inches long from tip of beak to end of tail, and of a pure white colour, with the exception of a few orange feathers over the base of the beak, which formed a sort of crest, bill yellow, and legs greenish brown. It was not provided with any of those special feathers which adorn our British species. The stomach contained a few remains of beetles.

But the dominant and characteristic bird of Pratas Island is the gannet. These birds measure 4 ft. 10 in. from tip to tip of wing, and 2 ft. 9 in. total length from beak to tail, which is wedge-shaped. The head, neck, back, and tail are fuscous, breast and belly white, legs and feet yellow, and completely webbed. They are common birds on most of these islands, and are well-

known to seamen. They fly heavily and usually low, fearlessly approaching within gunshot, and even stone's throw, and some of the men amused themselves with throwing lumps of coral at them as they flew by, the same bird returning again and again at the risk of being knocked down.

A walk through the interior of the island among the shrubs and bushes revealed to me the domestic economy of these birds. In the open places, and under the shelter of the bushes, the mother gannets were sitting upon their nests and eggs. The nests were mere hollows in the coral sand, strewed with a few bits of grass, with some admixture of feathers, and perhaps a bit of seaweed, forming, at best, a very rude cradle, in which were deposited two eggs. These eggs were about the size of goose eggs, white, with a suspicion of a blue tinge, not smooth and glossy like hens' eggs, but more or less scratched, as though the scratches were made when the external coat was soft, and had afterwards dried preserving the marks. One nest only contained four eggs. The poor bird sitting upon this nest would show symptoms of uneasiness as I approached, pecking the ground or coarse grass fiercely with its long, straight beak, but did not offer to quit the nest until I was within two or three yards of it, or even less. Then placing the end of its bill upon the ground, with a gulping effort it vomited up its meal, depositing it beside the nest, and floundering forward, took wing and rose into the air. This was the proceeding at nearly every one of the hundreds of nests which I disturbed; it was evident that the birds had just gorged themselves with food, and then sat down upon their eggs (unless, indeed, the mate had brought them food, a circumstance which I did not see myself), and that they were unable to raise themselves off the ground until they had got rid of the superfluous weight in their stomachs. On examining the vomited food, I found it to consist invariably of flying-fish, generally of a large size, and usually but slightly digested. There were sometimes six or seven of these fish, in other instances only three or four, and in two or three cases a squid or two intermixed with them. But what numbers of flying-fish must exist in the neighbourhood to afford such a daily supply to so large a number of birds! and yet we did not see a trace of flying-fishes about the island, and might otherwise have supposed there were none. Meanwhile the gannets formed a thick cloud overhead, the noise of whose screams and the rustling of whose wings formed a wild accompaniment of sounds. They flew so close overhead that I could have knocked them down with a stick in any numbers, and was obliged to wave my gun about as I walked along, in order to keep them from carrying away my hat. By degrees the birds rose higher, and those I had disturbed returned to their nests as soon as I had passed a few yards.

In the latter part of the afternoon a seining party came from the ship, and the nets being prepared, four casts were made very successfully. A great number of fish were taken and stowed away in the sail-bags, but it was too late and too dark to examine them very closely, and they were distributed amongst the ship's company and dressed for breakfast. Among them were a great many of a large silvery mullet; no flying-fish, however. In one of these hauls the net was so impeded by the quantity of the reticulated Ulva before mentioned, that it was drawn in with great difficulty.

It was now dark, and a breeze was springing up. A blue light burnt from the shore was answered by another from the ship, thus distinguishing her position, and Capt. Bullock and I embarking in the gig were soon scudding along under sail. Meantime the full moon rose grandly over the sea, and in half-an-hour we had measured the way back to the ship which it had taken two hours' hard pull to do in the morning.

The towing-net hanging out from the ship when lying off the island was, the first evening, filled with a dense brown deposit, which on examination proved to be composed solely of Zoëæ, all of the same species. The next morning on raising it again in the same spot, not a Zoëa made its appearance, but instead of them were numbers of Leucifer, Entomostraca, and other minute Crustacea, also little Atlantæ; fronds of reticulated Ulva, and decaying leaves of Zostera, upon which were Lunulites, Spirorbis, and minute Polyzoa.

A strong N.E. wind prevented us the following day from paying another visit to the island; while, lying under its lee, we remained at anchor for the sake of the shelter it afforded us. But on the second day, towards sunset, our attention was attracted by the curious phenomenon of long rolling waves coming in from the south-west, which increased as the evening advanced, causing considerable motion in the ship. Towards midnight these S.W. rollers increased to such an extent, the wind still blowing strong from the N.E., that Captain Bullock deemed it desirable to slip cable and put to sea, since the proximity of the reef was very undesirable if bad weather set in, while the rolling swell endangered our bumping upon the reef in a spot where our fair-weather anchorage left but little room to spare. We kept outside the edge of the reef therefore during the night, and next day approached its N.W. corner. Here we saw the terrible sight of the long line of breakers on our lee side, extending for miles along the northern edge of the reef, over which the sea, lashed into foam by a strong breeze of some days' duration, was dashing wildly in a broad straight band of white foam. Finding that the wind freshened and that we could do no more at the Pratas Shoal, we steered N.E. and left the dangerous reef behind.

The explanation of the curious phenomenon of S.W. rollers coming in with a N.E. wind followed in due time. They were caused by a typhoon which was blowing between 200 and 300 miles to the south of us, and which *recurved* in lat. 16° 10′ N. and long. 116° 30′ E., according to the observations of Capt. Symington, whose ship, the 'Northfleet,' was twice caught in it, and who published an account of the Cyclone.

Pratas Island being so small a spot and situated 170 miles from the mainland of China and about 250 from Formosa, it is remarkable that so many land-birds should have found a home there; and the incidents of the two or three days which elapsed during our passage from the reef to the Island of Formosa were particularly interesting, as throwing light upon this circumstance. Steering N.E. for Tacao-con, we experienced a strong head-wind the whole way, that is, the direction of the wind being in a straight line from southern Formosa to Pratas Island. We left the reef on May 3rd, on the 4th a large flock of sandpipers met us going with the wind towards Pratas, where no doubt they would find a resting-place. But the following day, being then a little more than halfway from the reef to Formosa, the rigging was scarcely free at any time during the day from feathered guests, which must have been driven off the Formosa coast by the wind, and some of them at least would have reached Pratas had they not found a resting-place and in some instances a passage back, on board the 'Serpent.' The following birds I observed at various times during the day, and sometimes several of them flying about the ship, and from time to time lying on various parts of the rigging; a yellow warbler (Sylvia), a yellow wagtail (Motacilla), a shrike (Lanius), grey with a black moustache, apparently identical with the one already seen on the island, two species of swallow (Hirundo), a small heron (Ardea), a very handsome blackbird rather bigger than a common blackbird, with a crimson beak and a large white spot on each wing, a very pretty red dove with a white head, a yellow and black spotted plover, precisely resembling the British golden plover, a species of flycatcher (? Myiagra azurea), and a bird closely resembling a hen chaffinch (? Munia topila).

This interesting assemblage of birds was evidently but a few of the numbers blown off the land (probably Formosa) by the force of a moderately strong N.E. wind, and of them, many would perish in the sea, a few would find relief and restoration in passing ships, and without doubt some would reach Pratas Island, and finding means of subsistence, would take up their residence there, and be jotted down in the Avi-fauna of the next observer.

II. NERVE STRUCTURE AND FORCE.

By Holmes Coote, F.R.C.S.,
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A superficial examination of the earth's crust shows, that from the most remote epochs there has been a succession of animal forms corresponding with the nature of the atmosphere in which such animals were framed to live; also that the transition from sea to estuary, and from estuary to river and thence to dry land, has been slow and without violence; and that among the marine strata there are mingled both animal and vegetable productions belonging to fresh-water life or the inhabitants of dry land. The study of geology therefore embraces not only the structure of the earth, but likewise natural history, comparative anatomy, and the physical sciences generally, and hence proves to its followers a source of endless intellectual enjoyment.

Among the early ideas, which strike us, is the important part played by the invertebrate or lower forms of animals, as compared with the vertebrate, in the history of the revolutions of the globe: through their ceaseless operations, islands are raised in the middle of the ocean, while from their débris such masses as those which constitute our chalk-cliffs are constructed. Whatever may have been the decree of the divine will as to their first creation, they must each in their generations have increased and multiplied until their missions were respectively accomplished. Some inquiry into their nature and organization becomes therefore interesting.

There are two great functions in operation in all forms of animal life, without which the race becomes extinct, namely, alimentation and reproduction. Even in the most complex organisms, such as man, endowed with the highest faculties and capable of the grandest mental efforts, the desire to "eat to live" and the fostering love of offspring constitute the most abiding emotions. In savage life the hunter will endure any amount of fatigue to secure his supply of food, and will fight to the death for the preservation of his young; and so among brute animals, though in a less degree, until, in the more simply organized, the love of self consumes all other feelings under the form of a reflex action of personal wants, and the young are provided for by those mysterious laws whose phenomena we may study, whose source and directing power we can refer only to the "One great Cause."

In the vertebrata, the organs of alimentation consist of a tube with oral and anal aperture; of teeth, to seize and grind; and of numerous accessory glands, such as parotid gland, liver, pancreas, &c. By means of these the nutritive material is prepared, that it may be subjected to other changes, which convert it into blood;

and then come excretory organs, such as the kidneys, to deprive the blood of all noxious principles. But in the invertebrata, the mode of alimentation is often more simple, although we may find the animal supplied with other organs fitted for its own preservation, but not directly for propagation, such as poison-bags, spinning apparatus of spiders, the ink-bag of the cephalopods.

Under most conditions in the animal world the act of reproduction takes place by means of an ovum or egg, which is fecundated by the spermatozoon, a mysterious germ moving about in a peculiar secretion. The organs, therefore, subservient to such functions are the most important. But other modes consist in the act of spontaneous fission or division of the parent animal, or by the act of budding or gemmation.

The young animal which leaves the egg is very often an exact counterpart of the parent, differing only in size, as in the case of the common chick; but in a vast number of instances this resemblance does not exist; sometimes the young require yet further evolution and change; in other cases there is no resemblance at all, either in form or mode of living; and this brood may repeat itself in its dissimilar character, or may again acquire the peculiar organs which bring it back to the parent shape. Then again we have the well-known metamorphoses as illustrated by the larvæ of insects, in which the offspring, though unlike the mother, passes through a definite series of changes, until it again acquires the parent form, again to reproduce in like fashion, and finally to die.

In all animals this function seems under the direction of what, for want of a better term, has been called "vital principle," "nerve power," &c.—not that brain ganglia or nerve fibres can invariably be found—but the changes are such as can hardly be explained on the ground of mere chemical affinity or of nutrition and assimilation.

What have we to say of nerve-power? Viewing it from its lowest manifestation, we may regard it as some dynamic force, evolved and regulated by co-existing, but yet unknown laws. Regarded from its higher attributes, we must incline to a principle of life, which is something superadded to ordinary laws, something which, while it lasts, keeps in abeyance the usual elements of deterioration and decay. Call it what we will, the ψυχη; the vital principle; its presence expresses life and creative or constructive action; its absence, decay, dissolution, degradation.

In the lowest forms of animal life, its presence is recognized by no known structure, but we soon observe nerve ganglia and fibres. They first appear about the oral aperture, their fibres extend to the radiating tentacles. The distribution of such nerve fibres and ganglia depends on the form of the individual, so that in myriapoda and annelida, they are repeated at segmental intervals, or concentrated in insecta, where the vitality is most clearly manifested in the head.

But as the higher manifestations of the mind become developed, so we notice that the accumulation of nerve-matter about the head increases; and that moreover there is a distinct line of demarcation between one kind of nerve substance, which is white, and another, which is grey; in other words, between the "nerve generators," or holders, and the "nerve conductors."

In the present communication my object will be to trace the relation between the habits of the animal and the functions performed by its different organs, with the apparent object of its mission. Such an inquiry, embracing the most comprehensive field of natural history, appears to me to exceed, in our day, the capabilities of a single individual; and my remarks must therefore be received only as a partial contribution towards our knowledge on the subject.

In both water and air, the two atmospheres which support animal and vegetable life, nature has provided means for maintaining purity and freshness. The antagonistic influences of animal and vegetable respiration have long been recognized, and similar provisions are made for fresh and salt water. The great sources of impurity in the two latter would proceed from the surface and from the deep, and not from the intermediate strata. On the former, and especially in warm climates, we should find hosts of insect forms; in the latter, multitudes of infusoria, small crustacea, and other denizens of the water.

It is said that if the young gnat were not devoured by fish, water-fowl, &c., the air would become darkened, even in this cold climate, by their immense multitudes. The same remark applies with greater force to the mosquito, each female of which lays annually, on the surface of water, about 300,000 ova. But there are yet other forms, more minute and microscopic, which in summer time may be detected in the spray thrown up by the paddle of the steamboat. What means are provided for keeping within bounds this exuberance of life?

Among the most beautiful appearances presented by the ocean is the silvery phosphorescent light, seen on a summer's night, illuminating the track of every boat and defining the contour of the waves. This subject has been studied by many naturalists, the foremost of whom is M. de Quatrefages, of Paris, whose researches on *Noctiluca miliaris* are too well known to require comment; and an important addition to our knowledge has also emanated from the labours of Professor Huxley. This luminosity proceeds in the main from living invertebrate animals—*Protozoa*, *Medusæ*, annelids, crustaceans. Among these the most important part is played by a singular and anomalous creature, of very simple organization, the *Noctiluca miliaris* just named. This form has been described as a gelatinous transparent body, about $\frac{1}{60}$ of an inch in diameter, having very nearly the form of a peach; where the stalk of the peach

might be, a filiform tentacle, equal in length to about the diameter of the body, depends from it, and exhibits slow wavy motions when the creature is in full activity. The body is composed of a structureless membrane; beneath this there is a layer of granules, or rather, a gelatinous membrane, through whose substance minute granules are scattered without any definite arrangement. From hence arises a network of very delicate fibres. There is an oral aperture, a sort of half oval, with a straight edge anteriorly, and a deeply curved outline posteriorly. From the bottom of the oral cavity a very delicate filament is occasionally protruded, which exhibits a rapid undulating motion, and is then suddenly withdrawn; doubtless, as suggested by Krohn, who first discovered it, the function is to sweep nutritive matter into the oral cavity. Close to the right extremity of the anterior oral margin, is a horny-looking S-shaped ridge, named by Huxley, a tooth, 1–7000 inch high. The oral aperture leads to the granular mass of the alimentary cavity, from which the fibres and the fibrils radiate.

What purpose now does the luminosity of *Noctiluca* serve? Passing down the Mediterranean in 1854 I was struck with its brightness and universality on most nights. Is it a voluntary act on the part of the animal, or is it determined only by reflex laws? In the fire-fly (*Lampyris Noctiluca*) it serves for the attraction of the sexes, and can be extinguished and renewed as the animal pleases. In *Noctiluca miliaris*, its purpose must be for the attraction of its minute prey: the oral aperture, its tongue and teeth all point to the fact that the animal is carnivorous, and serves to keep down those still more minute animal forms, which might otherwise render the water in which they live and generate, impure. But no distinct nervous system has here been traced.

Another class of marine animals, also carnivorous, the *Actiniæ*, live among rocks and broken surfaces, where they perform a similar purifying function, by the destruction of animals of larger form and of apparently much greater power than they themselves possess. But in these, as in the preceding, no trace of nerve matter can be clearly found, and yet they exhibit a power of selection which gives evidence of sense. If a young actinia be put within the tentacles of a larger individual, that fatal grasp is withheld, while a young crab or prawn is promptly seized and devoured. Its migrations, though slow, have usually some definite purpose; it avoids bright light, preferring the shelter of a piece of rock; it requires air, and will hang, tentacles downward, for hours from the surface of the water, floating by means of an air-bladder of its own formation.

Near the oral aperture we often see a series of bright spots, called Ocelli; they are not always present, and are subject to change of colour—are brighter at some times than at others. They have been considered by some as organs of vision placed on nerve ganglia,

but of this we have no anatomical nor optical proof; moreover, of what use would sight be to an animal so incapable of pursuit and unfit to avoid danger? They can serve no sexual purpose, for male and female organs are combined in the same animal. They may by their brightness attract other occupants of the ocean which are suitable for food, or they may be some of the earliest traces of nerve structure, acted on by light, and serving to direct the movements towards those regions where life may be best maintained.

Siebold expresses the opinion of most observers in saying that as yet only a very rudimentary and imperfectly-distinguished nervous system has been made out in the polyp; this consists of round masses, which are regarded as composed of nervous matter (ganglia) situated in the parenchyma. A ganglion of this kind has been supposed to have been observed about the mouth. Investigations upon their organs of sense have not been more successful. However, the sense of touch appears developed over the whole surface of the body, but especially so in the extremely irritable arms and tentacles; but, as yet, no tactile nerves have been found in these parts. In the same manner, light, to which these animals show a greater or less sensibility, is perceived rather by the general surface of the body than by special organs. There are, however, in some species, at particular stages of development during which they swim freely about, certain nicely-defined structures situated upon the sides of the body, and which may be regarded as special organs of light and sound. This is the case with *Syncoryne;* and *Coryne* has in their place four red organs, which correspond exactly to those found on the border of the disc of the pulmograde *Acalephæ*, and which have been regarded as organs of sense. The organ seen at the base of the six arms of *Eleutheria dichotoma* has quite the appearance of an eye; that is, there can be distinguished in it a cornea, a crystalline lens, and a red pigment layer surrounding the whole.

The Rev. W. Bingley, the author of an old but well-known work on Animal Biography, gives the following quaint but truthful account of the earth-worm, or as he calls it, the dew-worm (*Lumbricus terrestris*):—"The most insignificant insects and reptiles are of much more consequence, and have much more influence in the economy of nature, than the incurious are aware of; and are mighty in their effect from their minuteness (which renders them less an object of attention) and from their numbers and fecundity. Dew-worms, though in appearance a small and despicable link in the chain of nature, yet if lost, might make a lamentable chasm; for, to say nothing of half the birds and some quadrupeds which are almost entirely supported by them, worms seem to be the great promoters of vegetation (which would proceed but ill without them) by boring, perforating, and loosening the soil, and rendering it

pervious to rains and the fibres of plants, by drawing straws and stalks and leaves and twigs into it, and, most of all, by throwing up such infinite numbers of lumps, called worm-casts, which form a fine manure for grain and grass. Worms probably provide new soil for hills and slopes, where the rain washes the earth away, and they affect slopes, probably to avoid being flooded. Lands that are subject to frequent inundations are always poor; one great reason of this may probably be, because all the worms are drowned."*

Let us examine the worm more closely. Its colour is no matter of chance: the dark brownish-black hue, resembling the colour of the soil in which it lives, gives the best chance of escape from the keen-sighted birds which make it their prey: and of a similar provision we have numberless examples in both invertebrate and vertebrate divisions of the animal kingdom; in the former, for example, the green colour of the grasshopper, the brown hue of the cigale, whose abode is the dried branches of trees. Even the converse may be noted, namely, that colours may be made subservient to predatory habits, as we witness in the sandy-coloured lion, the inhabitant of a dried and parched soil; the striped and brilliant-hued tiger, which lives among the long grass of the jungle; or the panther, whose spotted hide may be mistaken for part of the leafy foliage among which it lies crouched.

The firm thick dermal covering and the muscularity of the earthworm are just such as would enable it to burrow in the moist soil: its thickness is great, and by reducing the size of the abdominal cavity serves to protect the viscera. The nervous system consists of a supra-œsophageal ganglion, united by two fine chords, surrounding the gullet with the sub-œsophageal ganglion, and thence proceeds a nervous chord along the abdominal aspect of the animal. There are no eyes, for sight is not wanted, but nerve-filaments go to the oral aperture, and to the appendages which proceed from it.

A circulatory system, consisting of a dorsal and ventral vessel, with transverse side branches, but with no very definite current of blood, is best adapted for the habits of an animal subject to sudden and unequal pressure, while the respiratory apparatus is an aqueous sac, lined with vibratile cilia within the abdominal cavity, on either side of the body.

The mode of reproduction is by a distinct sexual apparatus, which comes to maturity at fixed times of the year. In every animal there are both male and female organs, although the congress of the sexes seems necessary to impregnation.

It should be noticed that in the Annelids we first observe a trace of a "sympathetic nervous system," of which more will be said when speaking of more highly organized animals.

The acephalous mollusca are characterized by having a headless

* P. 500.

body, and a very large mantle, which so envelopes the body that there is a spacious cavity in which both oral and anal orifices are entirely concealed. Most are supplied with a calcareous covering termed the shell. The nervous system consists of a number of scattered ganglia, united by filaments with the œsophageal ganglia; there is a distinct circulatory apparatus; air-cells or branchiæ for respiration, and in many instances organs of vision. The mode of life of these animals, and the offices which they perform in nature, may be studied by the habits of the *Solen;* and the nature of the gasteropoda by the structure of the *Paludina,* or the *Buccinum.*

The oblong form of the bivalve razor-shell is well known; also the structure of its foot, which enables it, by change of form into a hook or a form of globular anchor, to sink or to rise in the soft sand. The *Solen* is essentially a sand-borer, penetrating to a depth of a foot and a half to two feet, rising for its food, and burrowing out of danger, and mostly maintaining its vertical position until death overtakes it, when its calcareous covering remains. The light sandy colour of the shell resembles the soil in which it lives; its cutting shape best enables it to divide the soft sand; its scattered ganglia diffuse sensation over the several parts of an animal requiring no active influence of centralized nerve force, but rather a lower power generally diffused over its irregular shape.

The scattered ganglia of the nervous system of the invertebrata, and the absence of a well-defined brain, constitute an arrangement by which the organic functions of the body may be best sustained, without the exposure of the animal to the perceptions of pain. The movements excited in its search after food must, in all probability, be reflex, and due in great part to the physical action of the rays of light; or currents caused by ciliary movements, bringing objects within its reach, which, when touched, are seized, swallowed, and digested. The act of deglutition brings the food within the influence of the secretion of a liver; but no regular periods of hunger prevail, and the animal can live long without taking food at all.

But ample provision is made for increase and procreation, and in many instances by more than one process in the same individual. The external senses consist chiefly of sight and touch, but the power is very feebly developed, so long as animals are fixed to rocks and other objects; on the other hand, in the invertebrata of flight, such as *Insecta,* the eyes are large and compound. Thus it is arranged that the rate of increase in regard to these animals is not under the disturbing influence of accident or passion; that the supply is constant and equal to the requirements of the earth, while the important changes which are effected by their death in countless myriads, either as framers of rocks, or as a supply of food to larger and more vigorous creatures, takes place without pain or suffering,

or those disturbing emotions of the mind, implanted with more or less intensity in all the vertebrate sub-kingdom.

The predacious habits of the Cephalopods, involving definite and rapidly executed powers of locomotion and prehension, with sight, hearing, and the exercise of choice, imply the necessity of a very different kind of nervous system. The central mass, it is true, forms an œsophageal ring, which consists of a superior and an inferior ganglionic mass, connected by lateral commissures. The superior is small, and sends some delicate nerves to the parts of the mouth. But the inferior portion is very large, and extends along the sides of the œsophagus in order to be directly connected with the broad commissures. An olfactory and two optic nerves arise from the lateral portion of this ganglion, while the auditory nerves have their origin from its inferior surface. From its anterior border pass off four or five pairs of large nerves to the arms, and also others to the muscles of the head. From its posterior border arise small nerves for the funnel, and also two large trunks for the back of the mantle.

The eye is composed of numerous membranes and is covered by the skin, which becomes transparent in passing over it, and sometimes forms folds that supply the want of eyelids. The ear is merely a little cavity excavated on each side near the brain, without semicircular canals or external passages, and in which there is suspended a membranous sac containing an otolite. The fleshy point of the tongue is undoubtedly a gustatory organ. There are olfactory organs situated in the neighbourhood of the eyes. The organ most highly developed is the organ of sight.

In the cephalopods we find well-marked "pneumogastric nerves." They arise from the middle of the inferior cerebral mass between the two pallial nerves, or nerves of the mouth; they descend along the neck behind the funnel, the posterior wall of which they pierce, and thence pass under the peritoneum, sending several nerves to the ink-sac and ramifying upon the heart; the large vascular trunks, the branchial hearts, and the branchiæ. There is moreover a distinct splanchnic nervous system.

A nervous system thus highly developed implies the active exercise of the organs with which it is supplied. The parrot-beaked mouth, the prehensile suckers, are structures which even the larger vertebrata would shrink from encountering. We read of the "*Sepia octopodia*," of the early naturalists, attaining in hot climates such a size as to measure twelve feet across its centre, and to have each of its arms between forty and fifty feet long! "When the Indians go out in their canoes," says Bingley, "in places frequented by these sepia, they are always in dread of their flinging their arms over and sinking them; on which account they are careful to take with them an axe to cut them off."* Without

* 'Nat. Biography,' p. 519.

First Appearance of Man.—From Figuier's 'World Before the Deluge.'

acknowledging such tremendous powers, we may mention that sailors who have irritated cephalopods with their boathooks, have had their naked arms, immersed in the water, suddenly seized by the suckers, while the animal in its fury has endeavoured to plunge its beak-like mouth into the flesh.

But these more highly organized and more locomotive animals do not appear to leave such lasting memorials of their presence as those of simple construction. Their mission is essentially destructive. They keep down redundancy of life, but we do not find that they raise atolls like the corals.

We must, however, qualify this statement by limiting it to comparatively modern times, for as the late Dr. Mantell remarked, "The living species are but representatives of the countless myriads which swarmed in the ancient seas."* Their fossil remains comprehend the most varied and striking forms of extinct beings that occur in the sedimentary strata, from the earliest secondary to the latest tertiary formations. Their fossil remains consist of the external shells, the osselet, or the internal calcareous support, the ink-bladder, with its inspissated contents or sepia; the mandibles, and some of the soft parts in a state of "molluskite."

This imperfect sketch of the nervous system of the invertebrates, and its relation to the functions which it performs, must serve as an introduction to the study of those higher types to which I hope at no distant period to direct attention. In these the relations of structure and function will be more clearly appreciable, and the connection between both and the objects of animal existence will be made manifest.

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†III. THE POLYNESIANS AND THEIR MIGRATIONS.

By Alfred R. Wallace, F.R.G.S., &c.

The origin of the various races of the islands of the Pacific has always been one of the most difficult problems for the believers in the unity and the recent origin of man. Their diversity of physical features, of civilization, and of language, the absence of any continental races to which they could be affiliated, and the wide spaces of ocean over which they are distributed, have hitherto seemed to indicate that their origin dates from a period so remote that we cannot hope to determine it with any approach to certainty.

M. Quatrefages, however, an eminent anthropologist, has courageously attempted to solve the enigma of the origin of the Polynesians, the most important of the Pacific races. He very properly

* 'Medals of Creation,' p. 448.

† 'Les Polynésiens et leurs Migrations,' par M. de Quatrefages, Membre de l'Institut, Professeur au Muséum. Paris, pp. 199. Arthur Bertrand, Editeur, 21, Rue Hautefeuille.

First Appearance of Man.—From Figuier's 'World Before the Deluge.'

limits this term to the brown races spread over a wide area from the Sandwich Islands in the north to New Zealand on the south, and from Easter Island on the east to the Tonga and Samoan groups on the west, but all speaking dialects of one well-marked language. Now what M. Quatrefages attempts to prove is, that these people are simply Malays, who migrated from some islands of the Malayan Archipelago (probably Bouru in the Moluccas), and have more or less intermingled with the races of Melanesia and Micronesia. His evidence to prove this is of two kinds:—first, he endeavours to show that a migration has taken place; secondly, that the Polynesians are in their physical, mental, and moral characteristics, a true Malayan race.

1. *Migrations.*—We find in M. Quatrefages' volume a very careful summary of all the native accounts of their migrations, and also of the involuntary migrations that have recently occurred. These, no doubt, prove that the Sandwich Islands and New Zealand have been peopled by emigrants from the Marquesas and Tahiti, and the fact of this emigration is confirmed by the independent evidence of language. It is proved, therefore, that the Polynesians have passed over immense spaces of ocean, in directions not especially favoured by winds or currents, and thus the difficulty of any migration, merely from its distance, is quite overcome. It is further shown that all the traditions point to the Samoan group and the Fiji Islands as the central points to which almost all Polynesians trace their origin. It is to be observed here that these are the largest of all the islands in the central Pacific inhabited by the Polynesian race, and it is these, therefore, that we should naturally expect to have sent out colonies to the smaller islands. So far we have the strongest corroboration of there having actually been a migration in the fact of the community of language, and all the legends of these migrations speak of them as having been made by simple men, the natural ancestors of the existing Polynesians. But in the legend which refers the origin of the Samoans themselves to a migration from a large country "further west," we get into pure legend,—for the mythic Boulotou, whence the first inhabitants are said to have come, is a spiritual and not a real country, and these inhabitants are believed to have been not men, but inferior gods. And even the direct evidence of migration having been generally from the west, is by no means so clear as M. Quatrefages appears to believe; for one of the latest authorities on the subject, Mr. W. T. Pritchard, who has spent his whole life in the Pacific, and who from his long residence in the Fiji and Samoan Islands as British Consul, and his intimate knowledge of the Polynesian languages, is well qualified to give an opinion on this matter, says it is just the contrary. In his 'Polynesian Reminiscences,' p. 402, he observes: "It is, however, remarkable that in all these many instances of authenticated driftings, the course of the

drifted canoes has been *from east to west*, before the prevailing trade winds, and *not from west to east* before the westerly winds;" during the prevalence of which he tells us the natives do not usually venture out on fishing or travelling expeditions. In this case, too, the corroborative proof by language completely fails, for though there is an undoubted Malay element in the Polynesian language, it is an element derived from the civilized Malay and Javanese tongues, not from those of the Moluccas, which are totally distinct.

It is to be noted also that this Malay element in the language has all the character of a recent introduction, since the Malay words are hardly changed, except by the phonetic character of the language which has received them.

2. *Physical Characters.*—The Malayan origin of the Polynesians at a comparatively recent date implies much physical similarity; for even if the Malay formed a still larger portion of the Polynesian language than it does, this would not prove a community of race, unless the physical characters also in some degree corresponded. It is here that we find an absolute defect of all evidence bearing upon the point in question—the similarity of the Polynesians to any race speaking the Malay language. Almost the only evidence adduced by M. Quatrefages goes to show the similarity of the brown race of Timor to those of Polynesia. But the Timorese are not Malays at all; they belong to that curious race which has close affinities to the Papuan in all moral and physical characteristics except colour, and their languages are much further removed from the Malay than even the Polynesian itself. The resemblance physically of this race with the Polynesian proves absolutely nothing with regard to the Malay question.

Now let us compare the most important and thoroughly well-established physical and mental characteristics of the two races:—

Polynesians.	*Malays.*
Tall, averaging—	Short—
5 ft. 10 in. . . Wilkes (Samoans).	5 ft. 4 in. or 5 ft. 6 in.
6 ft. . . Dupurey (Tahiti).	
Hair wavy, curly, or frizzly.	Hair always straight.
Beard often full.	Beard scanty or none.
Face handsome, European type.	Face never of European type.
Nose often aquiline.	Nose never aquiline.
Disposition active and joyous.	Disposition slow and morose.
Character open and frank.	Character eminently secretive.
Often erected stone edifices.	Never used stone for building.
Use double canoes.	Use single canoes.

In the following passages from Consul Hopkins' recent work on Hawai, the italicized passages show points in which the Polynesian is the exact opposite of the Malay:—

"The hair of the Hawaians is black or *brown*, strong, and frequently *curly*."

"The Hawaians are strong, well-made, and active, in height rather *above the average of Englishmen*. . . The Hawaians possess the virtue of *courage in an unquestionably high degree*. . . . They are now as peaceful a people as any upon earth; they are more *free from crimes of violence* than any nation that can be named. . . The natural disposition of the Hawaians is everything that is *opposite to the gloomy and morose*. The pleasant universal '*aloha*' or salutation, the *merry ringing laughter* of the women wherever found, proclaim the people to be a *light-hearted race*."

Taking the whole of these differences, they appear to indicate a radical diversity of race, not to be overcome by any mere similarity of colour and some common words in language, which is all that really exists to prove identity of race. The one single fact of stature is conclusive against any such comparatively recent common origin as M. Quatrefages argues for. A race which averages 5 ft. 10 in., and has many men 6 ft. 2 in. or more, can hardly have been derived, at such a recent period as to have retained community of language, from a race averaging 5 ft. 5 in. or 5 ft. 6 in., and among whom a single individual of 5 ft. 10 in. is rarely, perhaps never, found. Again, the hair of the Malay is of the true Mongol type—black, coarse, and perfectly straight. The least approach to wavy or curly hair is never found among the unmixed Malay. I cannot find evidence that the Polynesians *ever* have this character of hair, while it is undoubtedly often as frizzly as the most decided Papuan. Again, the mental character of two races in a parallel state of civilization and inhabiting very similar countries, is surely of great importance; yet, what contrast can be greater than between the phlegmatic, suspicious, undemonstrative Malay, and the active, frank, and joyous Tahitian? Are we to throw down all these barriers of diversity for the sake of solving by main force a problem that is probably insoluble?

3. *Geological and Zoological Evidence.*—M. Quatrefages dismisses with a very brief notice the proofs of a former much greater extent of land in the Polynesian area than now exists. These proofs are of two kinds: first, the existence of numerous groups of coral islands, which are admitted to indicate sunken land; and secondly, the distribution of animals in the existing islands. That coral reefs and atolls are proofs of a subsidence of the land, has never been seriously denied since Darwin's work on Coral Reefs was published; and as immense areas of the Pacific are occupied by such coral islands alternating with volcanic groups and such as show signs of elevation, it is only a question of time as to whether man could have inhabited these sunken lands.

Can we form any notion how long it is since the Pacific lands have disappeared? This can perhaps be approximately determined by the existing distribution of animals in these islands. The only

group we yet know with any approach to completeness are the Birds; and though these may not be supposed to be the best adapted to test a question of this kind, yet ornithologists know that a very moderate extent of ocean practically limits the range of most land birds. The total number of species found in any of these islands is very small. For example, if we exclude the waders, swimmers, and birds of prey as having roving habits and great powers of flight, we find that according to the best information only twenty-two species of land birds inhabit the group of the Society Islands, and of these seven are found in other groups ranging as far as the Marquesas, the Fiji Islands, and even to the Sandwich Islands. These are almost all birds of moderate powers of flight and such as inhabit the forests and mountains, and do not generally range far. In Mr. G. R. Gray's list of the birds of the Pacific Islands I find eleven species of the genera *Myzomela*, *Meliphaga*, *Tatare*, *Monarcha*, *Coriphilus*, *Eudynamis*, and *Ptilonopus*, which are known from two or more of the distinct and well separated groups of islands in the central Pacific, and some of them have a very wide range. Among these are two very distinct genera, *Tatare* and *Coriphilus*, which are entirely confined to the Polynesian area. Now these facts would certainly indicate a more intimate connection of the various groups of islands within the period of living species, and therefore within the human period, than now exists. The phenomena presented by the distribution of man are thus to some extent reproduced by the distribution of land-birds in the same area, and entitle us to believe that the subsidence of land indicated by coral reefs took place since man inhabited the earth. This subsidence was probably coincident with, perhaps caused by, the elevation of the existing volcanic islands; and while man and birds were able to migrate to these, the mammalia dwindled away and finally perished, when the last mountain-top of the old Pacific land sank beneath the Ocean.

This hypothesis is one which does not outrage nature, as does that of the direct and recent derivation of the Polynesians from the Malays. It harmonizes at once with the Geological, the Zoological, and the Anthropological phenomena; and if it is held that the facts are not sufficient to prove it, or that even if proved it only removes the origin of the race in question one step further back into the obscurity of the past, it may be suggested that in a case of such admitted difficulty we can hardly do more. We ought not to expect that the beginnings of every race are to be discovered within the short epoch of human history or tradition, and we have every reason to be suspicious of the theory that professes such a discovery. In the present case, the very erroneous views prevalent on the subject arise from two causes. One is the occurrence of a number of Malay words in the Polynesian language; the other, the similarity of the brown tint of the Malays and Polynesians,

while they are separated by a group of people of a much darker colour. The similarity of tint has led many travellers in the one area to jump to the conclusion that the people of the other area, of which they have little knowledge, are the same race. It unfortunately happens that not a single traveller appears to be well acquainted with both races, and for that reason their opinions as to the similarity of the two should be received with great doubt. If, on the contrary, my account of the physical and mental characteristics of the Malays be taken as correct (and I resided among them for eight years), and if it be compared with that of the Polynesians given by Cook, and by recent travellers and missionaries, the differences will be seen to be so striking and radical, that all idea of their being the same race must be given up. In the case of the Malays in particular, much confusion has arisen from travellers having confounded with them the many peoples of distinct race which inhabit the eastern parts of the Malayan Archipelago, such as the Timorese, the mountaineers of Ceram and Gilolo, and of the small islands near New Guinea; and this mistake has been rendered excusable by the number of half-breeds between the two races to be found everywhere. Many of these people are, perhaps, allied to the Polynesians,* but they are certainly not Malays, who are essentially a Mongol race, with many of the Mongol characteristics very strongly marked. The Papuans of New Guinea form the extreme type of another and a widely different race, and all the evidence goes to show that in every characteristic except colour, the Polynesians are nearer to the Papuans than they are to the Malays, although it is not improbable that they are equally distinct from both.

IV. LOUIS FIGUIER.

There are two distinct classes of scientific writers whose labours tend to raise the intelligence of our age; those who, by the publication of original researches (usually in the Transactions of Scientific Societies, or in the pages of technical journals), constitute the pioneers of scientific progress, and by their industry extend our knowledge of the laws of nature; and those again, who, appreciating the value of such original researches, and feeling the necessity for diffusing knowledge amongst the masses in a form in which it will be best understood by them, bring their literary powers to bear in a noble cause, and render comprehensible to the multitude laws and facts which would otherwise be appreciated only by the limited circle of what we are accustomed to call "Savans." Each of these two

* The mountaineers of Gilolo and Ceram are perhaps true outliers of the Polynesians, and may represent the effect of that *westerly* migration from Samoa, of which Mr. Pritchard speaks.

classes has its work to do, but unfortunately neither sufficiently appreciates the efforts of the other. The originator or discoverer of new facts and theories is too apt to regard the popular exponent of those laws as a "hanger-on of Science," pilfering where he cannot honourably gain; whilst the accomplished littérateur, to whom the patient investigator owes it that he and his newly discovered data are not consigned to oblivion in the archives of some learned but little known society, often entertains slight respect for the man who has but one idol besides science, and that is himself.

Of course there are many noble exceptions to this rule; and every day we find the number increasing. Men of research are beginning to cultivate their literary powers, whilst clever writers find it necessary to devote a larger amount of time to mastering the facts of science; and thus we have in every branch men who combine the rare talents of correct thought, careful investigation, and poetic expression; and the sooner all scientific men become sufficiently modest to appreciate the fact that they can best serve their noble calling by condescending to consult the tastes and feelings of the masses, or by availing themselves of the services of those who *can* gain the ear of the multitude, the sooner will science assume its true rank amongst the various branches of human intelligence, and its professors will cast away that stigma of vanity and self-conceit which often attaches itself to them.

Louis Figuier is one of those men whose ardour in the work of popularizing Science seems to know no bounds. Nothing comes amiss to him. He animates the dead and silent rocks, transports his reader with equal facility to the mute age of extinct Saurians, and to the tropical forests of to-day, alive with the songs of their feathered denizens.

Now, he conveys him on the wings of thought to the distant Coal period, lighting the way with the bright facts of Science; now, he descends with him into the Coal regions of our own time, initiates him into mysteries of the collier's craft, and relates in glowing terms how the precious fuel has been utilized to conquer the elements, to minister to man's tastes, desires, and necessities. To-day we may, if we choose, speculate with him upon the appearance of primeval man, whilst he was still struggling for supremacy with the hairy elephant, the hyena, and the cave-bear,* to-morrow we may observe with him how the hardy labourers of Spain or Algeria are engaged in stripping the bark of the Cork-tree.*

Not, however, that his scenic representations always render his scientific views quite comprehensible to us, or satisfy us that he is quite clear on all debated points himself; the strange jumble of Genesis and Geology, of the placid Garden of Eden and the wild Flint-folk, point to an element of superstition which it is to be

* See Plates.

regretted should have found its way into a work intended to enlighten the populace, and convey the results of advancing science.

M. Figuier (Guillaume Louis) was born at Montpellier, 19th February, 1819, and is the son of a chemist, and nephew of a professor of chemistry in that town.

He was admitted as Doctor of Medicine at Montpellier in 1841, and then removed to Paris with a view to study chemistry, which he did under M. Balard (of the Institute). In 1846 he was nominated by the Minister of Public Instruction to the post of Professor in the School of Pharmacy at Montpellier, and returned to his native town, where he remained five years engaged in his professional avocations. In 1850 he obtained the degree of Doctor of Physical Science at Toulouse; in 1853 he returned to Paris and secured a vacant Professorship in the School of Pharmacy, by competition; and from that time to the present he has been occupied either in original researches, chiefly in chemico-physiology, or in the compilation of popular scientific works. Of these the best known in England are naturally those which have been translated into our own language, and we now mean to devote a few pages to their consideration.

In his 'World before the Deluge'* M. Figuier, consistently with the views of modern men of Science, adopts the nebular hypothesis as his cosmical theory; but although he seeks to state it as fairly as possible, yet seeing that his nationality precludes him from following the latest researches of English physicists, and that Mr. Bristow, his able translator and editor, is a mineralogist, and not a student of physical science, we think it would have been better if he had passed over the hypothetical, and leaving the nebular theory to take care of itself, had commenced at the beginning of known Geological history.

It must not be supposed, from these remarks, that we object to the original speculations of professed geologists as to the origin of the earth, for these must necessarily precede or accompany the determination of the true character of its constitution, but in the volume before us we find the hypothesis, as enunciated in the 'Fortnightly Review,' of Mr. Tyndall put forward in support of the nebular theory, whilst the solid researches of Balfour Stewart, Miller, and Huggins are left unnoticed. It may be as clear to M. Figuier or to Mr. Bristow, as it is to Mr. Tyndall, that the luminiferous ether is infinitely more attenuated, but more solid, than gas; and "rather resembles jelly than air;" but if the author or translator had described the experiments of Stewart to show

* 'The World before the Deluge,' by Louis Figuier; a new edition: the Geological portion carefully revised and much original matter added by Henry W. Bristow, F.R.S. Thirty-four Full Page Illustrations of extinct animals and Ideal Landscapes of the Ancient World, by Riou; and 202 other figures. London: Chapman & Hall.

that probably there *is* an ether, and those of the eminent spectroscopic observers of the nebulæ, Huggins and Miller, which point to the existence of still unformed systems, his readers would have had sound scientific facts to guide them, and would have been able to compare them with the well-established data of astronomers.

As the matter stands at present, the arguments of M. Figuier or his translator are based to a large extent on hypotheses, which operate like a double-edged sword.

For example, the central heat of the earth inferred from the existence of volcanoes and hot springs in so many parts of the globe, and from the increase in the temperature of 1° Fht. for every 60 feet descent, is a very plausible argument in favour of the original state of igneous fusion, of which these phenomena seem to be but traces, but it is no proof. Although this increase in temperature as we descend is stoutly denied by some, yet it seems to be generally admitted; but the question still remains, could this state of fluidity exist at the centre consonant with the undoubted immense pressure of the circumference? Sir Charles Lyell* says:—"This theory seems wholly inconsistent with the laws which regulate the circulation of heat through fluid bodies; for if the central heat were as intense as is represented, there must be a circulation of currents tending to equalize the temperature of the resulting fluids, and the solid crust itself would be melted. Instead of an original central heat, we may, perhaps, refer the heat of the interior to chemical changes constantly going on in the earth's crust; for the general effects of chemical combination is the evolution of heat and electricity, which, in their turn, become sources of new chemical changes."

When Sir Humphry Davy succeeded in isolating the metals potassium and sodium, it was supposed that immense quantities of unoxidized metals might exist at great depths; and when water percolating through the rocks gained access to these masses, oxidation of the metals took place with the evolution of intense heat sufficient to melt neighbouring rocks, the hydrogen of the water would escape in the direction of least resistance, carrying with it molten lava, and producing the ordinary volcanic phenomena. Dr. Daubeny also supports this view, and there can be no doubt that chemical operation going on in the interior of the earth is sufficient to produce volcanic action of any degree of intensity.

With regard to the origin of life on our globe, M. Figuier does not dogmatize:—"Did plants precede animals, we cannot tell, but such would appear to have been the order of creation." Our globe, he thinks, during the Cambrian and Silurian periods was not yet mature enough for the existence of the higher organisms. "A

* 'Principles,' 9th edition, p. 545.

pale sun struggling to penetrate the dense atmosphere of the primitive world, and yielding a dim and imperfect light to the first created beings as they left the hand of the Creator, organisms often rudimentary, but at other times sufficiently advanced to indicate a progress towards more perfect creations." The absence of organisms more advanced in the zoological scale than were the Trilobites, is no proof that more highly organized animals did not exist on the globe during the Cambro-Silurian period. Those who think the Darwinian theory approximates to the truth, and especially those who hold the "complete" theory, will of course believe that animals classed as high among the Vertebrata as the Trilobites and Cephalopoda of Lower Silurian rocks are among the Annulosa and Mollusca, existed at that time in regions of the globe from which the ocean, perhaps, for ever excludes the inquiring palæontologist from verifying his conjectures. The discovery of the Eozoon Canadense in the Laurentian rocks, and the existence of beds of limestone in the same system, seem to confirm the views of those who regard the whole of the Sedimentary rocks, from the Silurian and Cambrian upwards to the latest Tertiary beds, as including but a partial and fragmentary record of the past life of the globe—impressions of the last-formed links of the great chain of organic life on our planet—a few of the last chapters in the book of 'Ancient Life.'

Limestone is almost in every case, especially when found existing over extensive areas, the result of organic agency, having been formed from the remains of marine animals, such as corals and various molluscs. Limestone is never a deposit from solution except in fresh water, and over very limited areas. Sea-water is computed to contain much more carbonic acid than is necessary to keep the lime existing in it in solution; so that when we find a limestone in a very ancient formation, although we may not be able to detect any fossil remains, yet we may reasonably infer that it is the result of organic agency.

The author describes the character and geographical extent of the rocks of the Cambrian, Silurian, and Old Red Sandstone periods; and enumerates and describes the typical species of each formation. He is particularly happy in his verbal pictures of those periods, as well as in that of the succeeding Carboniferous era. The author's efforts in this direction have been ably seconded by the artist, whose pictures of the animal and vegetable life of each period are admirably executed; indeed all the plates in the book are splendid specimens of wood-engraving, and are well printed, as will be seen from the accompanying specimens, for which we are indebted to the kindness of M. Figuier's English publishers. The student will find the restorations of extinct animal and vegetable life of much value, whilst the general reader will be no less instructed at

beholding such vivid representations of the manner in which nature decked the earth at various times during a period of untold ages.

The author seems to think that the internal heat of the earth affected the temperature of the surface almost as much during the Carboniferous period as it had done during the Silurian epoch. Indeed, he imagines that our planet did not experience what we call climate, until the commencement of the Tertiary period. "It is a remarkable circumstance," he says,* "that this elevated temperature combined with constant humidity does not seem to have been limited to any one part of the globe; the heat seems to have been nearly the same in all latitudes from the equatorial regions up to Melville Island in the Arctic Ocean, where in our days eternal frost prevails; from Spitzbergen to the centre of Africa, the Carboniferous flora is identically the same. When nearly the same species, now extinct, are met with under the same degree of development at the equator, as at the pole, we cannot but admit that at this epoch the temperature of the globe was alike everywhere. What we now call climate was then unknown, in geological times. There seems to have been only one climate over the whole globe. It was only at a later period, that is in Tertiary times, owing to the gradual cooling of the globe, that the cold began to make itself felt at the terrestrial poles. Whence then proceeds this uniformity of temperature which we now regard with so much surprise? It was a consequence of the excessive heat of the globe; the earth was still so hot in itself that its own innate temperature rendered the heat which it received from the sun superfluous and inappreciable." That there existed a uniformly high temperature over the whole globe, during the Carboniferous period, does not necessarily follow from the character of the vegetation alone. That a mild equable climate prevailed at that time rather than a very elevated temperature is the more reasonable inference: and we refer the reader to 'The Principles of Geology,'† for an admirable dissertation on the causes that might bring about such a universally equable climate. The same inference concerning a general prevalence of a high temperature over the earth might seemingly be drawn from the nature of the plants of the Miocene period, found in Iceland, North America, and Greenland, within the Arctic circle. Professor Ramsay,‡ speaking on this subject, remarks, "The meaning of this is not yet understood, for many of the plants are of a nature that seem to bespeak a warmer climate than that of the British Islands at the present day, and it is difficult to see how such plants could grow in Arctic regions, where there is not the stimulus of light during half the year. This is one of those things which we cannot explain, and about which we are waiting for light." Speaking of the genera of Carboniferous plants, Sir Charles Lyell§

* P. 120. † Ninth edition, p. 92.

‡ 'Physical Geography and Geology of Britain.' § 'Principles,' 9th edition, p. 87.

says, "These were formerly considered so closely allied to tropical genera, and so much greater in size than the corresponding tribes now inhabiting equatorial latitudes, that they were thought to imply an extremely hot as well as humid and equable climate. But recent discoveries respecting the structure and relations of these fossil plants have shown that they deviated so widely from all existing types in the vegetable world, that we have more reason to infer, from this evidence, a widely different climate in the Carboniferous era as compared to that now prevailing, than a temperature extremely elevated."

With regard to the physical formation of the beds of coal, M. Figuier embraces the theory generally accepted, that the plants grew and decayed in the places in which we now find the coal, and were not drifted from a distance.

He concludes his account of the primary rocks with a description of the Permian strata, and of the life of the Permian period. An awkward fact for the consideration of those who defend the theory of a high temperature in the crust of the earth itself at this epoch is thus noticed :*—"Although the Permian flora indicates a climate similar to that which prevailed during the Carboniferous period, it has been pointed out by Professor Ramsay as long ago as 1855, that the Permian breccia of Shropshire, Worcestershire, &c., affords strong proofs of being the result of direct glacial action, and of the consequent existence at this period of glaciers and icebergs. That such a state of things is not inconsistent with the prevalence of a moist, equable, and temperate climate, necessary for the preservation of a luxuriant flora, like that of the period in question, is shown in New Zealand, where, with a climate and vegetation approximating to those of the Carboniferous period, there are also glaciers at the present day, in the southern island."

We can see no analogy between the climate of New Zealand and the state of things described by M. Figuier as existing during the Carboniferous age, although there can be little doubt that the actual climatal condition of the greater part of the earth during Carboniferous and Permian times was something similar to that prevailing in New Zealand at the present day. That glaciers could not exist upon a surface having an elevated temperature, due to the conduction of heat from beneath, is self-evident.

The close of the Primary epoch was, he supposes, marked by local convulsions and disturbances of the globe; but we need not recur to any general cataclysm to explain the passages from one epoch to another, for we have seen, almost in our own day, certain species of animals die out and disappear gradually.

The life of the globe during the Palæozoic ages was characterized by very peculiar forms, both in the animal and vegetable kingdoms. The Graptolites and Cystidea of the Silurian rocks,

* P. 153.

the numerous genera of Trilobites, the bony-plated fishes of the Old Red Sandstone, and other curious forms, are exclusively confined to this period. The Rugose corals, with one exception, are likewise Palæozoic. Whilst the predominance of Brachiopoda among the Mollusca and of Crinoids among the Annuloida, gives a very marked character to the life of the period. Cryptogamic plants of strange forms and unusual size are most abundantly met with; and the microscopic structure of coal indicates that Gymnospermous Exogens were at this time plentiful.

In treating of the Secondary Epoch, M. Figuier adopts that arrangement which divides it into three systems or periods, *viz.* Triassic, Jurassic, and Cretaceous, with the Penarth or Rhætic sub-period, intervening between the Triassic and Jurassic systems, of which a concise and interesting account is given; and for this description the reader is probably indebted to the talented translator, Mr. Bristow.

The numerous remains of gigantic Saurians found in the rocks of the Secondary Epoch have led geologists to name it the *Age of Reptiles;* but the recent discovery of several genera of this class, in the coal measures of Kilkenny, in addition to remains and traces of reptiles previously found in Primary rocks, tends very much to do away with this term, and to deprive the Secondary Epoch of that almost peculiar feature which seemed to belong exclusively to it. The immense number of species of the general *Ammonites* and *Belemnites* seems now to be the only positive peculiar feature in the known life of this epoch. The absence of Mammalia higher than the Marsupial type rests, so far, upon negative evidence, and every advance in geological discovery proves the fallacy of reasoning on the non-existence of the higher forms of that or any other class from such data.

M. Figuier describes the lithological character of the rocks of each successive formation of this epoch. He enumerates the chief species of animals and plants, gives much information relative to the extent, condition, and development of these Secondary rocks, and describes minutely the structure and habits of such enormous reptiles as the *Ichthyosaurus, Megalosaurus, Plesiosaurus,* and *Iguanodon,* as well as the strange *Ramphorhynchus* and *Pterodactylus.* The non-scientific reader cannot fail to have his curiosity awakened to the study of geology by reading of an animal (the *Ichthyosaurus*) having "the snout of a porpoise, the head of a lizard, the jaws and teeth of a crocodile, the vertebræ of a fish, the sternum of the *Ornithorhynchus,* the paddles of a whale, and the trunk and tail of a quadruped."* Conflicts amongst enormous *Iguanodons* and *Megalosauri,* and angry meetings between strange looking *Ichthyosauri* and *Plesiosauri,* depicted with startling vividness by the artist, who presents us with vigorous and life-

* P. 197.

like pictures of the periods under consideration, will call to mind the fabled monsters of the Ancients—

"Gorgons and Hydras and Chimæras dire."

The late Professor E. Forbes's division of the stratified rocks into Palæozoic and Neozoic will probably be ultimately adopted, instead of Palæozoic, Mesozoic, and Caïnozoic. M. Figuier considers the Caïnozoic strata under the heads of Tertiary and Quaternary, including in the Tertiary, the Eocene, Miocene, and Pliocene formations, and in the Quaternary period describes the Postpliocene, and Recent Deposits. This portion of the work calls for no special remark. The plant-life of the globe at this period, as well as during the Secondary era, is not lost sight of, and is prominently discussed. Amongst the engravings are restorations of the chief Tertiary Mammals; those of the Eocene period so well known in connection with the name of Cuvier; and the gigantic Dinotherium is represented as an elephant with recurved tusks proceeding from the lower jaw. Recent discoveries, however, would seem to call for a considerable modification of our views respecting the affinities of this huge mammal, for further remains of this animal, lately found, are undoubtedly of a Marsupial character.

The principal features in the account of the Quaternary period are the descriptions of the "European deluges," the Glacial epoch, and the Asiatic deluge. The first of these deluges was caused by the sudden upheaval of the Scandinavian mountains: "as the regions in the midst of which this great mountainous upheaval occurred, as the sea surrounding these vast spaces were partly frozen and covered with ice, from their elevation and neighbourhood to the pole, the wave which swept these countries carried along with it enormous masses of ice. The shock produced by the collision of these several solid blocks of frozen waters (ice?) would only have contributed to increase the extent and intensity of the ravages occasioned by this violent cataclysm. The physical proof of this deluge of the north of Europe exists in the vast covering of unstratified earth which covers all the plains and depressions of Northern Europe."* The second European deluge was occasioned, M. Figuier supposes, by the upheaval of the Alps. We need scarcely say, there is not the least proof of either of these supposed deluges having taken place. All the phenomena attributed to their action are well known to be the result of icebergs formed in the mountain valleys, when the greater part of Europe was submerged, during the Glacial epoch. This part of the work seems to be crude and not well arranged. We find scarcely any attempt made to distinguish these diluvial deposits from those of glacial origin. The task would truly be difficult. That the Glacial epoch came on suddenly is proved, the author thinks, by the immense

* P. 367.

number of mammoths found frozen in Siberia. On this question again, an acquaintance with Lyell's 'Principles' would be of much service, but we cannot dwell on the subject. He seems to be at a loss, too, for any theory that will explain the existence of this intense cold, which he thinks came on so suddenly. Several astronomical theories are discussed, none of which he adopts. No diminution in the calorific power of the sun took place at this time, nor would any modification of the physical geography of the globe, that he is aware of, be adequate to produce this excessively cold climate; but this is the very direction in which he should have sought for an approximate explanation.

From considerations based upon a profound and comprehensive knowledge of the present physical geography of the globe, and the fluctuations in the relative position of sea and land indicated by the history of the sedimentary deposits, Sir Charles Lyell concludes that in past ages of the earth there might be, without reference to astronomical causes, such gradual changes brought about in the physical geography of the globe as to have at one period so high a temperature, prevailing all over the earth as to banish all traces of snow and glaciers, even from the highest mountains; and at another such an intensity of cold as might render the whole earth uninhabitable.

In the last chapter of the work M. Figuier treats of the origin of the human race, and of the Asiatic deluge. He does not believe in the ape-origin of man. The first man was placed on the earth by the Creator in the neighbourhood of the Euphrates. "There is no doubt," he says,* "that primitive man passed through a period in which he had to contend for existence with ferocious beasts, and to live in a savage state in the woods and savannas where Providence had placed him; but this period of his existence came to an end, and man, an eminently social being, by combining in groups animated by the same interests and the same desires, soon found means to intimidate the animals, to triumph over the elements, to protect himself from the innumerable perils which surround him, and to subdue to his rule the other inhabitants of the earth." This period in man's history, as it is held by the author, is the subject of one of his illustrations which we have selected for insertion, not, however, as a representation of what may be supposed to have been his appearance at that stage of his existence, but as an example of the admirable illustrations accompanying the work. It is impossible, in the present state of our knowledge, to "restore" man as he appeared along with the hairy elephant, the hyena, and the cave-bear. M. Figuier then describes the cave-deposits, peat-beds, shell-mounds, and lacustrine habitations, and discusses the evidence of the contemporaneity of man and certain extinct animals.

* P. 407.

The Noachian deluge was the result, he conjectures, of "the upheaval of a part of the long chain of mountains, which are a prolongation of the Caucasus. The earth opening by one of the fissures made in its crust in the course of cooling, an eruption of volcanic matter escaped through the enormous crater so produced. Masses of watery vapour or steam accompanied the lava discharged from the interior of the globe, which, being first dissipated in clouds and afterwards condensed, descended in torrents of rain, and the plains were drowned with volcanic mud. The inundation of the plains over an extensive radius was the instantaneous effect of this upheaval, and the formation of the volcanic cone of Ararat, and the vast plateau on which it rests, altogether 17,323 feet above the sea, the permanent result."*

With this extract we must close our notice of M. Figuier's 'World before the Deluge,' a book which will probably be regarded in future ages as a fair illustration of the mixed views held by the various thinkers of our days on geological and palæontological questions.

Every reader will find something to his taste, and the feelings of none will be outraged by too great one-sidedness. There is the plate of the Garden of Eden, with our first parents and Cain, and the Biblical account of the Deluge for those who cling to tradition, whilst there are calm discussions, well-arranged data, and the beautiful illustrations to support a belief in the antiquity of man and his contemporaneity with the great extinct mammifera. Leaving M. Figuier to render these views consistent with each other, we pass on to his 'Vegetable World,'† an exquisite work, which has just been issued as a companion to the 'World before the Deluge.'

If excellent paper, legible type, beautiful illustrations, and good printing be any recommendation to a book, this work should have an extensive sale. The first part of the volume treats of the structure of the various organs of plants and their functions. Commencing with the root, the various kinds of which are fully described, it passes on to the stem; the varieties, structure, and mode of growth of acrogenous, endogenous, and exogenous stems are clearly explained; buds, boughs, and branches successively engage the reader's attention; a brief notice of the different modes of grafting is given, and the structure, functions, and different forms of the leaf are described in a pleasing manner. "Leaves," he says,‡ "transform themselves into other organs with wonderful facility. It is, in fact, by modification of the leaves that nature produces many essential organs in the life of plants." This law of Morphology is often inaccurately stated.

* P. 418.

† 'The Vegetable World: being a History of Plants, with their Botanical Descriptions and Peculiar Properties.' 446 Engravings and 24 Full Page Illustrations, chiefly from Nature. Chapman & Hall, 1867.

‡ P. 83.

Gathering Bark from the Cork Tree.—From Figuier's 'Vegetable World.'

The converse of the first sentence of the preceding extract is frequently observed. A leaf is never transformed into any other organ; but where we should expect stamens, carpels, petals, &c., leaves are often abnormally developed. All the organs of the plant are formed upon a plan, of which the leaf is taken as the type. This doctrine of Goethe has been long recognized by all botanists. And tracing the homologues of the leaf in the various forms assumed by flowers and fruit, constitutes one of the charms of botanical study to the young student.

Exhalation, respiration, and circulation in plants are then glanced at by the author, before proceeding to describe the various parts of the flower and their functions.

The different kinds of inflorescence and varieties of fruits and seeds come under review; and lastly, the interesting phenomena of fecundation and germination are investigated, bringing the portion devoted to organography to a close. The chapter on fecundation is extremely interesting, and is written in a popular style. "When the existence* of sexual differences in vegetables was first propounded, the discovery produced general astonishment. If the most convincing proofs had not established it, if the commonest observation had not allowed every one to verify its reality, it would certainly have been classed among the most singular inventions ever issued from a poet's imagination; but the proofs were convincing. The demonstration of the existence of sexual organs in vegetables became a brilliant and unexpected fact, exhibiting a wonderful analogy between animals and plants, filling up in part the gulf which had hitherto existed between the two great classes of organic beings, yielding an inexhaustible fund of reflection and comparison to naturalists and thinking men.

"The ancients had very vague ideas on this subject. Yet we learn from Herodotus that in his time the Babylonians already distinguished two sorts of Date Palmes. They sprinkled the pollen of one on the flower of the other, in order to perfect the production of the fruit of that valuable tree.

"Cesalpin, an Italian philosopher, physician, and naturalist, who, in the 16th century, was professor of medicine and botany at Pisa, remarked that certain sets of *mercurialis* and *hemp* remained sterile, while others were productive. He considered the first as the male sets, and the second as the female. In the 17th century, Nehemiah Grew, a learned English Fellow of the Royal Society of London, published in 1682 an anatomy of plants; above all, Jaques Camerarius, a German botanist, born at Tübingen, showed the precise use of the two essential parts of the flower, and the part that each plays in producing the fecundation of germs. In a letter now become celebrated, *De Sexu Plantarum*, published in 1694,

 * P. 177.

Camerarius completely proved the great fact of the existence of the sexes in plants just as in animals. This discovery made an impression on the minds of naturalists; it was, in fact, one of the most striking victories which natural science had obtained." *

The portion of the work devoted to systematic botany is preceded by a sketch of the history of botanical science from the time of Aristotle, giving an account of the labours of Grew, Tournefort, Ray, Magnol, Linnæus, Bernard de Jussieu, Adanson, Laurente de Jussieu, De Candolle, Robert Brown, Dr. Lindley, and other great botanists; and it forms a very appropriate introduction to the study of that department of the science. Dr Lindley's son has lately written to the 'Athenæum,' complaining of the unfair use made of his father's works in compiling the 'Vegetable World.' M. Figuier and his editor quote largely from Dr. Lindley's works, and adopt his classification of plants; but their obligations to him are honourably acknowledged in numerous instances, and the translator and editor pays the following tribute to his merits:†—"His knowledge of vegetable structure was extensive and profound. His indefatigable industry and unequalled powers of generalization enabled him to grapple with and bring to perfection the vast scheme of rearranging on physiological principles, after careful structural examination, the whole vegetable world. His 'Vegetable Kingdom' remains a monument of immense learning, technical knowledge, and vast industry. The modern school of botanists may be said, one and all, to have been his pupils, and the system he has framed is probably the nearest to perfection which the world has yet seen." The classification proceeds in the ascending order, commencing with the Diatomaceæ. We should prefer De Candolle's subdivision of the class Exogens into Thalamifloræ, Calycifloræ, Corollifloræ, and Monochlamydæ, to that adopted.

We were somewhat puzzled for a moment at seeing the pages in which the genera Fraxinus, Olea, Solanum, Nicotiana, Atropa, &c., are described, headed "Rosals;" but this is a typographical error, and will, no doubt, be rectified in the next edition.

The engravings, we are told in the preface, are all from nature. They seem to have been drawn from living nature, and not from dried specimens, as sometimes seems to be the case in works on botany.

The concluding portion of the book is on the geographical distribution of plants, and is not the least interesting portion; but want of space prevents us from giving any further extracts, for we have still to deal with M. Figuier's labours in other departments of human intelligence.

Perhaps one of his most attractive productions is after all his 'Merveilles de la Science,' and those who have seen the book will not be surprised to hear that it has had a very large sale in France. It is a work still in progress, and first appears in numbers at 10 cts.

* P. 177–8. † P. 220.

each, and then in series; and if some enterprising English publisher would arrange for its republication in England—taking care to add a fuller account of those British inventions to which M. Figuier naturally devotes a more limited space than to those of his own countrymen—we have little doubt that the venture would prove remunerative.

'Les Merveilles de la Science'* is a handsome quarto volume, containing a most agreeable history of the Steam Engine, Steam Boats, Locomotives, Electrical Machines, Lightning Conductors, the Voltaic Pile, and Electro-Magnetism. Doubtless many of his illustrations are fanciful; at least they represent events in the history of Science (such as "James Watt, étudiant le perfectionnement de la machine de Newcomen") which were at the time of so little importance in the eyes of the world, compared with the butcheries of successful generals, that they are not likely to have boasted a special limner; but be that as it may, the sketches of the various scenes on scientific history are very attractive, and are typical of a phase in historical studies not to be met with in any similar work. Were it only for his pleasing reminiscences of the scientific History of Britain, we could not help giving our tribute of admiration to M. Figuier's work, where the reader will find sketches of "Savery in the Tavern," "Humphrey Potter, or the Lazy Genius," "Black making experiments on Latent Heat," various reminiscences of James Watt and the Soho Works, &c.

The foreign scenes are also excellent, and the portraits, commencing with that of Bacon and ending with Ruhmkorff, appear very good, and are certainly of an order hardly to be expected in a serial at ten centimes. When we add that one of the last sketches is that of Wilde's magneto-electrical machine, which appeared in our number of last October, it will be evident that M. Figuier is not unconscious of the latest scientific novelties.

Indeed it is not likely that he ever will be far behind his age as long as he continues to compile and publish another work before us, 'L'Année scientifique et industrielle,'† to which we shall now devote a few closing remarks.

The frontispiece to M. Figuier's "Annual" represents the eruption of the Volcanic Island of Santorin, copied from a photograph, and its contents comprise accounts of all events and discoveries of note in every branch of science, with accounts of the proceedings of scientific societies, and obituaries of eminent men; indeed it greatly resembles our own "Chronicles of Science." M. Figuier should, in future, request some English friend to look over

* 'Les Merveilles de la Science, ou description populaire des Inventions modernes.' Par Louis Figuier. Paris: Furne, Jouvet & C^ie^. 1866.

† 'L'Année Scientifique et Industrielle, ou Exposé Annuel des Travaux Scientifiques, des Inventions et des Principales Applications de la Science à l'Industrie, aux Arts, &c.' Par Louis Figuier. (11^me^ Année, 1866.) Paris: L. Hachette & C^ie^. 1867.

his work, and rectify errors in English names, such as that of Brande, which he spells Brandes, for he must know that the brotherhood between the scientific circles of France and England is becoming more and more intimate every year, and increased accuracy is required in the record of their respective labours.

It is to promote the closer union of the scientific men on either side of the Channel that we have chosen M. Figuier as the subject of this memoir. We might, it is true, have selected Frenchmen more deeply versed in some particular branch of science, and better known in our own scientific sphere; but we think that the account we have given of the useful and varied labours of M. Figuier, the favour with which his treatises have been received in England, and the influence they are likely to exercise upon his own vivacious and somewhat volatile countrymen, sufficiently justify our choice in this respect, and we hope to receive many more works from the pen of the same zealous and accomplished author.

V. THE VENTILATION OF COAL MINES.

By Robert Hunt, F.R.S., Keeper of the Mining Records.

The terrific explosion of fire-damp in the Oaks colliery near Barnsley, by which more men were killed than were ever sacrificed in any mine in the world at one time, and the scarcely less sad calamity at the Talk-o'-th'-Hill colliery in North Staffordshire, have forcibly drawn attention to the modes employed for the extraction of coal from the inclosing rocks. The results of the inquiries instituted have served to prove that, in the colliery where the greater number of lives were lost, all the arrangements were such as would be produced under the most satisfactory management; whilst in the other there were evidences of neglect arising from the lax system of discipline which prevailed. Therefore, in re-examining the question of ventilation—which appears necessary, since we desire to remove some of the numerous errors which prevail—we may keep before us with advantage these Yorkshire and Staffordshire collieries as representing respectively a good and an imperfect system of coal-mining.

The Inspector's reports, which have been published regularly for ten years, inform us that about 1,000 men are killed annually in this country, in raising our coal from its bed. This has been long known, but, excepting by those who are directly brought in contact with the coal-mining population, it has passed unheeded. It is only when a great catastrophe occurs—and scores, or it may be hundreds, of men are killed—that public attention is aroused, and directed to

APPARATUS USED FOR PENETRATING DANGEROUS GASES IN MINES

1. Galibert's 2. Hall's 3. Bourgeois'

the lamentable fact, that the agent which gives us so much comfort at home, and which enables us to maintain our manufacturing and commercial supremacy abroad, is obtained at such a mournful cost. Men then ask one of another, cannot this be prevented? and many an active mind, perfectly innocent of any knowledge of the conditions of a coal-mine, at once favours the world with crude suggestions. Floods of letters appear in the newspapers, many of them indicating the strongest possible desire to do good, but at the same time most of them show a want of that acquaintance with the physical facts and the mechanical appliances, which must be closely studied and familiarly known, ere any—even the least—improvement can be hoped for, in the practice of coal-mining. Nor is our legislature free from this spasmodic effort to effect a good. For years the reports of Her Majesty's Inspectors have been laid on the table of the House of Commons. They have regularly told the tale, which we now repeat, and yet no member has felt sufficiently interested in the matter to make an earnest effort to secure a better state of things.

We are indebted to Mr. Atkinson, H. M. Inspector of Collieries for Durham, for the following compilation, showing the results of fatal accidents which have occurred during the last ten years.

	Tons of Coal raised.	Miners killed by—			
		Explosions.	Falls of roof.	Shafts.	Miscellaneous.
1. Northumberland, Cumberland, and North Durham	92,825,433	186	308	118	529
2. South Durham	126,240,072	48	292	110	359
3. North and East Lancashire	59,991,875	238	268	132	148
4. West Lancashire and North Wales	70,442,000	169	358	227	216
5. Yorkshire, Derbyshire, and Nottingham	89,616,315	340	238	130	79
6. Leicester and Warwick	60,980,319	52	228	115	150
7. North Stafford, Shropshire, and Cheshire	41,900,000	121	202	156	112
8. South Staffordshire	76,483,405	126	745	319	112
9. Monmouthshire, Gloucestershire, and Somersetshire	52,894,500	231	354	96	102
10. South Wales	64,951,136	412	530	123	292
11. East District of Scotland	54,208,000	27	216	93	82
12. West District of Scotland	59,082,897	69	214	91	53
Total	849,615,952	2,019	3,953	1,710	2,234

Summary for Ten Years.	No.	Per cent.
Deaths from fire-damp explosions	2,019	20·36
Falls of roof and coal	3,953	39·87
Shaft accidents	1,710	17·24
Miscellaneous accidents in mines and above-ground	2,234	22·53
	9,916	100 00

A close examination of these returns gives the following mean annual average of miners killed, by each class of accident, in each inspector's district.

	Explosions.	Falls of Roof.	Accidents in Shafts.	Sundry Causes.	Total in each District.
1. Northumberland, North Durham, and Cumberland	30·1	33·0	12·1	59·3	135·5
2. South Durham	6·2	34·0	9·4	20·2	69·8
3. Lancashire N. and E. Division	11·3	27·1	12·2	10·3	60·9
4. Lancashire W. and North Wales	19·0	34·3	19·1	11·2	83·6
5. Yorkshire	21·2	25·0	13·0	7·2	66·4
6. Derbyshire, Nottinghamshire, Leicestershire, Warwickshire	2·4	22·1	10·4	14·1	49·0
7. North Stafford and Cheshire	9·0	20·0	22·0	8·1	59·1
8. S. Stafford and Worcestershire	11·4	75·3	31·3	10·1	128·1
9. Monmouthshire, Gloucestershire, Somerset, and Devon	31·4	35·0	8·0	7·3	81·7
10. South Wales	33·1	55·1	11·0	25·1	124·3
11. Scotland E.	2·2	23·4	9·3	5·0	39·9
12. Scotland W.	6·2	22·3	8·2	3·2	39·9
	163·5	406·6	167·0	181·1	918·2
Ironstone Mines in connection with coal-fields	6·1	40·0	30·0	15·0	91·1
Total	169·6	446·6	197·0	196·1	1009·3

1. The number of accidents involving loss of life in each year . 851
2. The number of lives lost in each year by the above accidents 1009·3
3. The number of collieries in the United Kingdom 3,256
4. Accidents therefore occur annually at rather less than one-third of the collieries.
5. A life is lost annually at one-third of the collieries.
6. Quantity of coal raised annually . . . . . 98,000,000 tons.
7. Therefore a life is lost for, of coal raised . . . . 97,135 ,,
8. Value of the coal raised at pit's mouth £24,500,000
9. A life is lost in the production of coal valued at . £24,390

We learn also from this examination, that explosions of fire-damp are not the most frequent causes of death. There are killed in each year :—

By explosions of fire-damp	169·6
Falls of roof	446·6
Accidents in shafts	197·0
Sundry causes	196·1
	1009·3

Of course, the loss of nearly 400 lives in the two terrible explosions of last year will greatly elevate the average for some years to come. But the Barnsley explosion must, in its disastrous results, be regarded as an exceptional case, as we shall endeavour to show.

With great industry Mr. Wm. Green, jun., has collected

"Chronicles and Records" of the Northern coal trades. This carries us back to 1180, and gives a table of accidents. We have since 1658* imperfect and intermittent records of the colliery explosions, and when the workings in our collieries were far less extensive than they now are, we find some very serious accidents.

At Fatfield colliery, in Durham, in 1708, sixty-nine lives were lost; and in 1710 between seventy and eighty perished in the Bensham colliery. Until towards the end of the last century the lists of accidents are few; not that they did not occur, but it was thought unwise to report them. In 1767, we find in the 'Newcastle Journal' the following curious paragraph:—"As so many deplorable accidents have lately happened in collieries, it certainly claims the attention of coal-owners to make provision for the distressed widows and fatherless children occasioned by these mines, as the catastrophes from foul air become more common than ever. Yet, *as we have been requested to take no particular notice of these things, which, in fact, could have very little good tendency, we drop the further mentioning of it.*" This paragraph appeared on the 21st of March, and, on the 27th of the same month, a second explosion occurred at Fatfield colliery, already mentioned, by which 39 men were killed.

Since that period the most serious accidents from explosions, in the great Northern coalfield, have been the following:—

1778.	Chartershaugh Colliery	24 lives lost.
1794.	Picktree „	30 „
„	Harraton „	28 „
1799.	Lumley „	39 „
1805.	Oxclose „	38 „
	Hebburn „	35 „
1812.	Felling „	92 „
1813.	Fatfield „	32 „
1815.	Newbottle „	57 „
1817.	Harraton „	44 „
1821.	Wallsend „	52 „
1823.	Rainton „	59 „
1830.	Jarrow „	42 „
1833.	Springwell „	47 „
1835.	Wallsend „	102 „
1839.	Hilda Wallsend „	52 „
1844.	Haswell „	95 „
1845.	Jarrow „	40 „
1849.	Hebburn „	31 „
1851.	Wallsend „	34 „
1860.	Burradon „	74 „
1860.	Risca Black Vein „	142 „

In 1815, 75 men were drowned in Heaton colliery by an inundation, and in 1862, 204 men perished in Hartley colliery by suffocation: the shaft having been closed by the breaking of an immense pumping-engine beam, one-half of which fell into it.

* 'Transactions of the North of England Institute of Mining Engineers,' vol. xv., 1865–6.

In other districts the most serious accidents from explosions have been the following:—

1852.	Nitshill, Scotland	61 lives lost.
	Gwendreath, South Wales	27 ,,
	Middle Dyffryn, Aberdare	68 ,,
	Coppul ,,	36 ,,
1853.	Bent Grange, Oldham	20 ,,
1854.	Warren Vale, Rotherham	52 ,,
	Ince Hall, Lancashire	89 ,,
1856.	Cymmer, Rhondd	114 ,,
1857.	Lundhill, Barnsley	189 ,,
1858.	Bardsley, Ashton	53 ,,
1862.	Cethin, Merthyr	47 ,,
1862.	Edmund's Main, Barnsley	59 ,,
1866.	Oaks	about 300 ,,
1866.	Talk-o'-the-Hill	91 ,,

The examples which have been given show that the coal-miner has to guard against a terrible enemy; and although a larger number of deaths occur in our coal-pits from other causes which demand our most serious attention, it is necessary that, for the present, we should dwell exclusively on the conditions under which fire-damp is formed, and on the methods which are adopted to remove it or render it inactive. This article addresses itself to the intelligent reader who may be desirous of receiving correct impressions upon a subject of great general interest; therefore the student of science must excuse the, to him, rudimentary details, which are thought necessary.

Numerous theories have been, from time to time, promulgated relative to the formation of coal, and many of them have been received, by our most able geologists, as explaining the observed phenomena. No one can deny the vegetable origin of coal; its chemical composition, its physical conditions, and the evidences of embedded plants, are sufficiently satisfactory. But that coal has been formed from woody fibre, rather than from the succulent parts of plants, or from plants containing but little wood, is not by any means so evident. Several microscopic observers have thought that they have detected ligneous structure in coal; but when the same sections have been submitted to the botanist, he has generally decided that no such structure was apparent. This is spoken of the true old coal, and has no reference to Tertiary coal (Bituminous Wood, Lignite, &c.). Goeppert,* to whom we are indebted for many valuable researches on coal, says, "there are but few varieties of coal in which their vegetable origin can be detected by anatomical examination; and even in Tertiary coal the change is so far advanced, that scarcely anything more can be recognized than a few elementary organs." "Coal," writes

* 'Poggend Annal,' vol. lxxxvi., p. 482.

Bischof,* "consists chiefly of the stems of Stigmaria, Sigillaria, Lepidodendra, and Calamites, in the more or less perfectly preserved bark of which may be recognized the characteristic leaf cicatrices." Wherever these plants have been discovered in our coal-beds, the only portion which has been converted into coal, has been the bark; the woody portion has, by the operation of the law of substitution, become stone, but never coal. The writer of this article has sought over every coalfield of the United Kingdom for an example of wood converted into coal, in vain; nor has he been successful in obtaining such a specimen from any of the coalfields of Europe or America.

It is not denied that woody matter may have played its part in the formation of coal; but if it has done so, every trace of wood has been lost by the changes which it has undergone, previously to its being deposited as part of a bed of coal. It may not be amiss, as showing the chemical evidence adduced, to place together the results of a few analyses, omitting the earthy matter, which exhibit the difference in chemical constitution between Wood, Turf, Lignite, and Coal.

	Carbon.	Hydrogen.	Oxygen and Nitrogen.
Wood—mean composition	49·1	6·3	44·6
Turf from Dartmoor	60·0	6·0	33·8
Brown coal from Bovey	67·9	5·8	24·0
Lignites from the Rhone	74·2	5·9	22·5
Coal, Newcastle	87·9	6·5	12·6

"It may be some time before we fully understand the processes in operation during the conversion of woody fibre into the curious mineral substance, coal. The only way of attaining such knowledge is to examine carefully the gases eliminated during its progressive alterations, and endeavour to follow out the proximate changes which have produced these ultimate products of transformation."† However, without admitting that ligneous tissues have been principally concerned in the formation of coal, which is Bischof's assumption, it is not denied that they may have formed no inconsiderable portion of the vegetable mass, which was to be, by a series of changes, eventually converted into Bituminous Coal.

Vegetable matter in its various stages of decay, and under different conditions, is found to exhibit—

1. The separation of carbonic acid and carburetted hydrogen.
2. „ „ of carbonic acid and water.
3. „ „ of carburetted hydrogen and water, or
4. „ „ of all three.

Consequently, except where the oxidation of the carbon alone takes

* 'Elements of Chemical and Physical Geology,' vol. i., p. 260.

† 'On the Gases evolved during the Formation of Coal,' by Dr. Lyon Playfair. 'Memoirs of the Geological Survey of Great Britain,' vol. i., p. 460.

place, carburetted hydrogen is constantly evolved. The following are a few of Playfair's analyses of the Gases of coal-mines :—

	(1)	(2)	(3)	(4)	(5)	(6)
Oxygen	0·9	..	..	0·6	3·0	..
Nitrogen	6·7	6·4	6·9	14·2	12 3	4·9
Carbonic acid . . .	0·7	1·1	0·3	2·1	2·0	1·7
Light carburetted hydrogen	91·8	92·7	92·8	83·1	79·7	93·4
Hydrogen	..	..	..	..	3·0	..

Consequently we may infer that the production of the light carburetted hydrogen, which constitutes, when mixed with atmospheric air, the explosive fire-damp, is either a continuation of the process by which the coal has been formed, or that during the mutation resulting, eventually, in coal, this gas has been largely developed, and *retained* in the coal-bed, under enormous pressure, and consequently in a most condensed form. Few persons who are not familiar with our coal-beds have any idea of the state of high tension in which the carburetted hydrogen exists in them. Mr. Thomas John Taylor, who was one of the most experienced and scientific of our colliery viewers, stated, before the Mining Institute of Newcastle-on-Tyne, "that the mean annual quantity of gas evolved from a barred-up district of fifty acres, in the Bensham seam at Wallsend colliery, was thirty-four and a half millions of cubic feet, equal to the solid contents of a coal-bed five feet thick and 160 acres in extent."

With this statement before us, it will be readily understood how, when such a reservoir is suddenly tapped, by cutting a fissure or otherwise, the outburst of gas must overpower the best possible ventilation. Coal usually lies in widely extended beds, spread out horizontally, or nearly so. The labours of the miner are directed to the extraction of these beds from their seats, deep in the earth, at the least cost, with the smallest waste practicable, and of course with as little risk as possible. This is effected in several ways, in different districts, the principle observed being—by whatever method the coal may be worked—to prevent the fall of the stratum above the coal—"the roof"—when the coal is removed; and so to arrange the "ways," that a constant current of air may circulate through them. The more common methods are those called respectively "pillar and stall" and "long-wall" working. In the first of these large oblong pillars of coal are left to support the roof, and a colliery so worked may be well represented, by placing piles of books a few inches apart on a table, and covering all of them with a board. The books will represent the pillars, and the spaces between each pile, the passages of the mine. After a period, in such a colliery, it is customary to "draw the pillars," for thus will be obtained a large additional supply of coal. This is effected by removing these oblong supports, beginning at the most remote part

of the workings, and allowing the roof to fall in: this forms a waste, commonly called the "goaf" or "gob."*

The "long-wall" mode of working consists in carrying passages to the extremity of the property, and then working away the coal in one long face, supporting the roof by props for a time, and eventually, by walls formed of stone from the mine.

A word or two on mining appears necessary. The order of the operation is this:—The coal is cut and got by "hewers;" it is then moved in the tubs through the first passages by "putters;" horses draw several of these tubs to the shaft-foot, and these are drawn to the surface by the steam-engine. Only one of these processes—the hewers'—has any direct effect on the liberation of gas, but they all have an important bearing on the plan of the underground roads and methods of ventilation. The roof which overlies the cavities made in removing the coal by the hewers may have a tendency to fall in, and pour inflammable gas into the "roadways" or "air channels." The "thill" or floor may, being relieved from the pressure of the superincumbent masses, be subject to heave and discharge gas upwards; there may be in front of the workings, especially along lines of dislocation, undiscovered reservoirs of such gas: it may have accumulated in the broken ground or "goaf" (which has been described), which, once abandoned, is rarely ever explored again. All these may be regarded as sources from which gas may flow, and, under a judicious system of working, they should be carefully guarded against. The main source, however, of inflammable gas, and that which yields by far the greater, but not the most dangerous, supplies, is the cutting of the fresh coal in the ordinary process of every-day work. "It will be observed," says one of the inspectors, "that about three-fourths of the explosions take place in stagnant places in 'winning forward' new drifts, where the openings were in course of being made, and the ventilation not brought close up to the face." This will satisfactorily show that the coal is in its natural condition constantly evolving gas, and that the admission of atmospheric air has nothing to do with the liberation of the fire-damp gas.

Coal is cut by the "hewers" in two directions, at right angles to each other; these are called "boardways" and "headways."

It is found as a matter of experience, that in driving "boardways course" whatever gas exists in the coal comes off more freely from the numerous fissures which *are cut across*. In most seams of coal a definite structure is observable, innumerable small fissures are found to run in a uniform direction, or nearly so; this

* Goaf is equivalent to the *Gob* of the Midland Counties, and the "Vugh," or "Vugha," of the Cornish miners. It is probably of Cymric origin—from "Ogof," a cave or hollow. The *Gogofau*, or *Ogofau*, is the name of a Roman gold-mine near Pumpsant, in Caermarthenshire.

is called "cleat." In cutting across these fissures, more gas is liberated than when working "headways course," or parallel to those fissures. Thus we learn that gas is not *generated* in the coal during the process of working, or by the release of pressure; but, that it is poured out of cavities, in which it has long been pent up, because these cavities are laid open. The more free and open the cleat structure, the more easy and regular the flow of the released gas.

From the quantity of nitrogen detected by Playfair in the gases examined by him, it has been supposed by some that atmospheric air has permeated the fissures of the coal, and set up chemical action; "for we are ignorant of any process of decomposition which would eliminate it in an isolated form. The process of decay and putrefaction would cause its separation as ammonia, and the action of heat would produce the same effect." The presence of carbonic acid—always, however, in small quantities,—which has been detected, has been adduced as further evidence of the action of atmospheric air on the coal, after it has been opened by the miner. These hypotheses are unsupported by the evidence we obtain in the pits. Every stage in the operations of the miner shows that this carburetted hydrogen has been accumulating for ages in the mass of the coal, and that it is liberated in the process of working out the bed of coal.

It should not be forgotten that coal-beds vary very greatly in respect to their gaseous accumulations. There are some districts in which "fire-damp" is unknown. There are even beds of coal which contain much carburetted hydrogen in some parts, while other parts are entirely free from this gas. It is not easy to account for this difference. In all probability, the age of the coal, the conditions under which the coal was formed, and the length of time during which the masses of coal-plants were exposed to atmospheric conditions, before they were buried under the strata of sand and shale which now cover them, determined the physical conditions of the bed.

Some idea may be formed of the rapidity with which the inflammable gases pour forth by an example or two. On one occasion at Seaton-Delaval, 4,900 cubic feet of gas were evolved in three minutes. At Hebburn colliery, where the process was continuous, about 1,500 cubic feet of explosive mixture was formed in two hours. Occasionally the outburst of gas is with explosive violence, overpowering any system of ventilation which can be established.

Such are the circumstances,—very briefly stated,—of the conditions under which the dangerous atmospheres of our collieries are produced. Let us now examine the methods which are adopted to secure the removal of those dangerous gases as quickly as they are formed.

It is well known, that as we descend into the Earth, by means

of a shaft, the temperature increases, and it increases in some ratio with the depth. Mr. Edward Hull has given, as the result of observations made in the Duckinfield colliery in Cheshire, an increase of 1° Fahr. for every 83·2 feet in depth. Professor Phillips obtained results in Monkwearmouth colliery which appeared to show an increase of 1° F. for every 60 feet of depth. The results arrived at by Mr. Robert Were Fox, in the deep mines of Cornwall were, that for the first hundred fathoms, the increase of temperature was 1° F. for every 50 feet; in the second hundred fathoms, 1° F. in every 60 feet; and for the third hundred fathoms, 1° F. in every 75 feet: thus showing that the increase was in a constantly diminishing ratio. In addition to the natural heat in a mine, the temperature is increased by the lights employed and by the breathing of the men and horses. Therefore the air, after it has passed through a mine, is of a higher temperature than when it entered. Such heat acting upon the air of a mine rarefies it, and passing into the "upcast" shaft presents a column of air specifically lighter than that in the "downcast" shaft. Thus a continual current of air is produced down one shaft, it travels around the workings, and up another shaft; this constitutes what is called NATURAL VENTILATION. Mr. Nicholas Wood has shown that at Seaton pit, the shaft, having a diameter of 14 feet, equally divided by a timber brattice, airtight from top to bottom, and a depth of 1,560 feet, the length of the air courses being 3,036 feet, by merely natural ventilation 7,002 cubic feet of air passed out of the upcast side of the shaft per minute, the temperature of the air entering the mine, at the top of the *downcast*, being 47° F., and of that leaving the mine, at the top of the *upcast* shaft, 62·5° F. It will be evident to any reflecting mind that the greater the difference between the temperature of the air entering a mine and on leaving it, the more powerful will be the *mechanical* force exerted by the heat. Hence in winter natural ventilation is far more effective than in the summer, at which season the surface temperature is so slightly different from the subterranean, that very little movement takes place.

It being a necessity to secure a constant motion of the air through every portion of a colliery's workings, and for this motion to be of sufficient rapidity to carry off, as quickly as it is evolved, the gas from the coal, an artificial system must be established. The first obvious method would clearly be, to heat the air in one of the shafts, or in one division of the shaft, where one only existed; hence the introduction of furnace-ventilation. The ventilating current is produced by the difference of density between the air passing down one shaft, or one side of a shaft, and that passing up;—the amount of current varying with the square root of the difference of temperature between the columns respectively; so that if it were necessary to double an air-current, the difference

of temperature would have to be quadrupled. The amount of current varies with the square root of the depths of the upcast shaft; thus, to double this, the shaft or chimney must be made of four times the original height. Again, the resistance of an air-current increases with the square of the velocity, and inversely as the area of the spaces traversed. These facts show that a furnace being constructed for the purposes of ventilation, and placed under the best possible conditions, cannot, in cases of sudden emergency, be greatly augmented in power.

The principles for securing the greatest advantage from the heat of a furnace are,—first, to maintain as high a temperature as possible in the upcast shaft; and secondly, to place the source of heat —the furnace—at the bottom of the shaft, supplying the fire with air which has not passed through the workings. It has been often argued that greater ventilating power can be obtained by using the return air rather than fresh air to urge the combustion of the coal. This is no doubt true, and in many collieries it may be safely applied; but there is always greater safety in exciting the fire with fresh air, and directing the return air into the heated shaft, without allowing it to pass over the incandescent fuel.

The shaft is a chimney; the higher you can heat that chimney, the more rapid will be the current moving up it. At Hetton colliery, 190,000 cubic feet pass by the furnace in each minute. At Haswell colliery, 100,917 cubic feet; and at Wallsend, 122,000 cubic feet. In these large collieries the extent to which ventilation is carried is necessarily greater than in less extensive works, where the liabilities to the presence of explosive gases are less. In the West Riding of Yorkshire, for example, we find the rate at which air passes the upcast shaft is,—at Ardsley Main, 30,957 cubic feet; and at Darley Main, 30,780 cubic feet.

Some years since, Mr., now Sir Goldsworthy Gurney, introduced what has been called steam-jet ventilation. He found that a jet of steam issuing under pressure, at high velocities, dragged the air forcibly with it. At Seaton Delaval, where this system was admirably applied, the rate of the air-current was found to be 82,320 C. F., and 74,391 C. F., as the average of a great many sets of experimental trials.

Mechanical ventilation must now receive consideration. The machines adopted for the ventilation of mines, although varying considerably in structural details, may all be referred to one or other of two great classes, namely:—1. Those exhausting the air by direct expansion and compression in a cylinder or chest; and, 2. Those producing a vacuum by centrifugal action. The latter includes the various kinds of fans, while the former is represented by the piston and cylinder machines.

The oldest machine of the first class is that which, under the name of the Harz air-pump in Germany, or duck machine in Corn-

wall, has for centuries past been almost the only artificial ventilation employed in metal-mining. It consists of a square wooden box, open at the bottom, which is moved up and down by a reciprocating rod, in a cistern partly filled with water; a pipe communicating with the working of the mine rises in the centre of the cistern, a little above the level of the water, and is stopped by a valve opening outwards. As the box rises, a partial vacuum is formed within it, into which the foul air from below rises as soon as the difference of pressure is sufficient to overcome the small resistance offered by the weight of the valve. At the return stroke, the aspired air is compressed and drawn out, either through a second pipe communicating with the external air, or, what is more generally the case, through discharging-valves fixed on the top of the box. The use of the duck machine is generally confined to ventilating the end of a single gallery, and for such purposes it is well adapted, being of a simple and inexpensive construction. The power necessary to drive it is usually obtained by attaching it to the main rod of the pumping-engine.

Machines upon this principle have been constructed for colliery ventilation, of very large dimensions, one of the most important examples being that erected by M. Devaux at Marihayes, near Seramy, in Belgium. It has two wrought-iron cylinders or bells, 12 feet in diameter, and 8½ feet high, which are put in alternating motion by a horizontal steam-engine, one rising as the other descends. The cistern is annular, of about 10 inches greater diameter than the bell. The interior space or air-chamber is closed at the top, the air-way being formed by sixteen large balanced valves, opening outwards, a corresponding series being fixed in the roof of the bell.

A modification of this machine, called by the inventor and patentee, Mr. W. P. Struvé, an "airometer," has been in use for some years past in South Wales; the bells are, however, without valves, and are driven by a rotary motion of a reciprocating engine. The intake and discharge valves are in connection with outer cylinders of masonry, one set being placed below and the other above the bells. The whole arrangement is, in fact, an imperfect form of double-acting blast cylinder, having a water-joint instead of tight packing on the piston; but the valves being placed vertically instead of horizontally, allows them to be made much tighter, thus giving an advantage over the more perfectly constructed Belgian machine.

An airometer at Westminster colliery, Denbighshire, with a single bell of 17 feet in diameter and 6½ feet stroke, making eight double strokes, was found to draw 23,608 cubic feet per minute, the average pressure being about 1·41 inches of water.

The single-acting blowing cylinder, with a tightly fitting piston, similar to that formerly employed in forges, was at one time used

to a considerable extent in France and Belgium, but does not appear to have been successful. More recently, however, this form has been revived, with the important modification of placing the cylinders, or rather air-chests—a box of square section being usually employed—horizontally instead of vertically, so that the valves may be made of large sectional area without any counterbalance; the pressure against the seat when closed being very much less than is the case in the vertical cylinder. Prominent among this class is that known as Nixon's machine, which has two single-acting boxes and pistons, each 20 feet square, and making a stroke of 30 feet. It is of comparatively recent introduction, and is mostly used in South Wales. The essential conditions for the successful construction of a machine of this class are great lightness in the working parts, and the use of guide rollers to keep the weight of the piston from wearing out the packing unequally.

Fabry's pneumatic wheel and Lemielle's ventilator are examples of machines with cylinders and rotating pistons. The former consists of three horizontal fans, each with three blades, suspended in a pit bounded by walls, forming segments of circles. The air is scooped up by the advancing blades in passing these portions of the pit, and is prevented from returning through the unenclosed portion, by a system of interlocking plates at right angles to the main air-way on the opposite sides of the shaft. Although a comparatively simple contrivance, it is difficult to express its mode of action clearly without illustrative drawings. The amount of air discharged per revolution is comparatively small, with reference to the size of the cylinder described by the points of the blades; but, as it is driven continuously, a steady current can be kept up by working it at a moderate rate of speed.

Lemielle's machine may be best described as a common feathering paddle-wheel, with only two or three float-boards, which is placed eccentrically, and made to revolve in a circumscribing cylinder, provided with intake and discharging passages nearly opposite to each other, the axis of the wheel being placed vertically instead of horizontally. The blades corresponding to the float-boards in the paddle-wheel are kept, by their eccentric rods, in close contact with the wall of the cylinder as the axis revolves, from the moment they pass the intake until they reach the discharging port, where the volume of air included between two following blades passes out into the atmosphere.

The usual dimensions of these machines are as follow:—Diameter of the drum, about 10 feet; of the outer cylinder, 13 feet; length of blades, 7 feet; when making from 20 to 30 revolutions per minute, the effective difference of pressure produced is from $\frac{1}{2}$ to $1\frac{1}{2}$ inches of water.

In the second, or centrifugal, class of ventilators, fans of all kinds have been adopted at different times, both in this country

and abroad. Formerly, those with curved blades, arranged so as to discharge the air inspirated from the entire circumference simultaneously, were used in the North of France; but the small effect given by them, when compared with the power expended, has led to their abandonment, and at present the simple forms with straight blades and slightly eccentric drums, similar to the older forms of foundry fans, though, of course, of much greater dimensions, are mostly in vogue. The following are among the more important examples:—

Nasmyth's fan, at Abercarne, has eight wrought-iron radial arms, carrying thin sheet-iron blades 3½ feet wide and 3 feet long, the effective diameter is 13½ feet, the drum, or casing, is open all round, and has two passages in the centre for the admission of the air drawn from the mine. It is driven by a single high-pressure engine, of 12 inches diameter of piston and 12 inches length of stroke, and when making from 60 to 90 revolutions per minute, aspirates from 45,000 to 56,000 cubic feet of air per minute, under a pressure of from 0·5 to 0·9 inch of water.

In Guibal's fan, which is extensively used in the North of France, and has also been introduced in the northern coalfield of England, at Elswick and Pelton collieries, the outlet of the drum is provided with a shifting lip, in order that the area of the aperture through which the discharge takes place may be increased or diminished according to the speed of the arms. Another improvement consists in the use of a tapering chimney with an increasing section, in order to diminish gradually the velocity of the air leaving the fan before it reaches the external atmosphere, whereby a considerably increased pressure is made available, which, under ordinary circumstances, is lost when the air is thrown out at the circumference at an unnecessarily high speed. The construction of the fan offers no special peculiarities. Six arms are usually employed; but for the largest size it is proposed to increase the number to eight; the diameter varies from 22 to 30 feet, and the breadth of the arms from 7 to 13 feet. The amount of air drawn per minute is about 105,000 cubic feet, at a pressure varying from 1½ to 3½ inches of water.

Such are the means which have been adopted to urge currents of air, with rapidity sufficient to sweep from all the passages of the mines any accumulations of fire-damp. Yet, notwithstanding all the attention which has been given to this matter, we are constantly hearing of the most disastrous explosions. Nearly all of these may, however, be referred to carelessness—sometimes so gross as to amount to wilfulness—on the part of the colliers. Naked lights may be forbidden, safety-lamps may be locked, and all possible care taken to secure the proper amount of ventilation. After all, a man or a boy leaves a door open, and thus deranges the

current of air. Men, though forbidden, will smoke; and the fact of finding lucifer-matches in the pockets of men who have been killed, tells us how reckless a man the collier is.

Professor Phillips, in his "Report on Colliery Explosions," has the following remarks:—

"Abundant currents of air may be so misdirected as to yield bad ventilation; the safety-lamp may be so unwisely handled as to endanger the lives it should protect; the best regulations may, if not strictly carried out, become sources of mischief. The general remedies for these errors, or crimes, are instruction and responsibility; increased knowledge, and stronger motives to use it rightly —knowledge is nowhere more powerful, obedience nowhere more necessary, than in a coal-mine."

Until the young miners are instructed in the necessity of observing, with all strictness, the rules which superior knowledge has proved to be essential to their safety, we cannot hope to prevent those calamities, which we so much bewail.

A larger number of miners perish from the effects of the "after-damp," or "choke-damp"—carbonic acid—than from the actual explosion of fire-damp. When the mixture of carburetted hydrogen and air is exploded, the carbon combines with oxygen to form carbonic acid, and the levels become filled with this deadly vapour. Carbonic acid kills by asphyxia: the action of the heart ceasing with the inhalation of irrespirable gases. Now, could those who were rendered insensible by the after-damp be speedily removed to pure air, they might be, by a little careful attention, restored to animation. It therefore becomes of the first importance to have at hand the means which would enable men to penetrate the dangerous gases and rescue their comrades. The most simple method is to place in a coarse bag a mixture of powdered Glauber salts—the sulphate of soda—and lime. This tied over the nose and mouth, effectually absorbs the carbonic acid, and prevents its exercising any injurious effect on respiration.

Many plans have been devised for enabling men to penetrate dangerous gases. One was by a well-known colliery-viewer of Newcastle, Mr. T. Y. Hall, which partook of a permanent character. Safety-pipes of any satisfactory material were to be laid down in the "thill," or floor of the main galleries of the mine, in the direction taken by the air, from the top of the "downcast" shaft into the workings, and back through the "return" to the "upcast" shaft. These pipes to be provided with boxes or joints, at intervals of about 40 or 50 yards—such is the permanent arrangement. An air-tight dress or casing is constructed, which can be so secured,—as is the diver's dress—that the man wearing it breathes only the enclosed air. Flexible tubes from the dress can be connected with the boxes or joints on the safety-pipes, and these tubes removed at will by

the explorer: having advanced the 40 or 50 yards, which is the length of the flexible pipe, it is unscrewed and attached to the next joint, so that he breathes the pure air passing through them even in the midst of an atmosphere of death.

M. Galibert's respirating apparatus for enabling any one to penetrate dangerous gases, such as carbonic acid, is so much more simple that it must be briefly described—especially as it has met with the approval of the Academy of Sciences of Paris. A reservoir of air is carried on the back, fixed by means of braces and a waist-belt. This reservoir is a bag formed of an exterior envelope of linen, sufficiently strong to resist the roughness of the rocks or coal, with which it may come in contact. Upon this is laid a much finer linen cloth, each cloth being covered with repeated layers of india-rubber, which causes them to adhere very closely. The capacity of the bag may be varied; but M. Galibert usually makes it to hold 140 litres (1·760 to the pint), which will allow a man to remain for thirty-five minutes in the most deleterious gases without inconvenience. From this bag tubes extend over the shoulders; and they are provided with a nose and a mouth piece, which are properly secured. The man with this apparatus adjusted takes the air from the reservoir, and respires again into it. He breathes the same air many times over without experiencing any inconvenience. He knows when it is time for him to think of retreat, as his respirations become more frequent; but after the first warning he can remain seven or eight minutes without danger. This apparatus occupies but half-a-minute to prepare and adjust; it requires no instruction for its use; and with it any one can remain half-an-hour in the level of a mine filled with "choke-damp," and thus probably rescue many who would otherwise perish. M. Galibert states that, from experiments made with his apparatus, he finds that the quantity of air absorbed is about nine litres per minute when in repose; and in walking at the rate of six kilomètres (between three and four miles) an hour, is rather more than ten litres a minute.

We must briefly refer to another form of apparatus for penetrating inflammable and irrespirable gas in collieries, and invented by M. Rouquayrol, engineer to the Aveyron collieries in France. This apparatus consists of a reservoir, which is made of thick iron plates, capable of resisting pressures of twenty-five and forty atmospheres. The air is injected by means of very ingenious pumps, in which the pistons are fixed and the cylinders move. When charged with air, the apparatus is placed on the back like a knapsack. A kind of mechanical bellows is placed on the top of the reservoir, allowing the air, although at a very great pressure, to enter the lungs at the ordinary pressure. A little exterior valve, formed of two leaves of india-rubber, which are held together by the pressure of the atmosphere, opens itself to let out the

respired air. In this apparatus the air is sometimes distributed to a particular kind of lamp at the same time as to the lungs, where an ordinary lamp or a Davy could not be used; but in this case an electric light burning in a closed tube is always the safest means of lighting. In the accompanying plate each of these three kinds of apparatus is represented; and for the drawings of the apparatus invented by M. Galibert, and that of M. Rouquayrol, we are indebted to 'La Vie Souterraine' of M. Simonin—a book of much interest, which we understand will be published in English by Messrs. Chapman and Hall.

Provided with this apparatus of Rouquayrol, a man can breathe with the same ease under water; some successful experiments have been made at the bottom of rivers and at the bottom of the sea. The apparatus is far preferable to the awkward and heavy apparatus which is usually worn by divers. In mines it may be used, if necessary, for working under water at the bottom of sinkings, as for repairing broken pumps.

In M. Rouquayrol's arrangements provision is made for supplying air to a lamp. A much more simple and ingenious arrangement has been invented in this country by Mr. Samuel Higgs, junior, of Penzance. The object of this invention is to provide a good and safe light in exploring the dangerous parts of coal mines, or, in cases of accident, to ensure a continuous light in searching for any unfortunate miners who may still be alive, but unable to escape without aid. The lamp consists of the best form of the Davy lamp, with a steel cylinder below it. Into this atmospheric air is condensed by an ordinary air-pump. There is a tube through which the air is admitted to the flame, within the wire-gauze, and the quantity required is regulated by a screw valve, as shown in the annexed woodcut. The weight of this lamp complete is not more than five pounds, and a good and safe light can be maintained for some time.

We call attention to these arrangements in the hope that they—or some modification of them—may be so far adopted as to be always at hand in collieries where they are working upon seams of coal known to be fiery.

It was our purpose to have remarked on the methods by which a safe and sufficient light is obtained for use in the coal-mines; and also to have examined into the value of Ansell's very ingenious Fire-damp Indicator. The question of ventilation, although popularly treated of, has, however, occupied the space which is, at present, at our disposal.

VI. BELGIAN COMPETITION IN THE IRON MANUFACTURE.

By Bernhard Samuelson, M.P.

To appreciate the capacity of a country for producing Iron, it is necessary in the first instance to ascertain its facilities for supplying fuel.

Belgium possesses extensive deposits of Coal, and an industrious population. The colliers of Belgium are content to earn on the average barely one-half the daily wages paid in this country; but owing to the great dip of the seams of coal, and to other causes, the labour of extraction is greatly in excess of that in most parts of the United Kingdom, and consequently the cost of labour *per ton* is far greater than in our coal-mines.

For instance, the average cost of ordinary labour in the pit and at the pit's mouth is, in the district of Liége, 3*s.* 2*d.* per ton, and in that of Hainault, 4*s.* 9*d.* per ton.

In three pits fairly representing the various conditions of coal-mining in the North of England, the corresponding wages, during the last six months of 1866, were, on the average,—

No. 1 Pit.	No. 2 Pit.	No. 3 Pit.
1*s.* 7*d.*	1*s.* 6¾*d.*	1*s.* 10½*d.*

The charges for propping, &c., are proportionately greater in Belgium than in this country; and the general result is, that the price of coal at the pit's mouth per ton is, at Liége 10*s.* 6*d.*; Hainault 13*s.*, against North of England pits, 5*s.* to 6*s.* 6*d.* per ton.

So onerous are the prices of fuel to the Belgian iron manufacturers, that on the 8th of January they resolved, at a meeting held at Liége, to take measures for procuring a supply from the Prussian coal-fields.

The coal-mines of Belgium—

Produced, in 1865	11,840,703 tons
Against, in 1863	10,345,330 „
Increase in two years	1,495,373 „

The coal-mines in the United Kingdom—

Produced, in 1865	98,150,000 tons
Against, in 1863	86,292,000 „
Increase in two years	11,858,000 „

Thus the average annual ratio of increase of production has been as nearly as possible the same ($6\frac{1}{2}$ per cent.) in each country.

But the *increase* alone on the two years in this country, is equivalent to the *entire production* of Belgium.

The production of Iron in Belgium was—

In 1865	455,035 tons
In 1861	311,838 „
Increase in four years	143,897 tons;
	or about 11 per cent. per annum on 1861.

The production of Iron in the United Kingdom was

In 1865	4,819,254 tons
In 1861	3,712,390 „
	1,106,864 tons;
	or about 7 per cent. per annum on 1861.

But it will be seen from the preceding figures that the average *increase alone* of the production of Iron in this country in two years is, like that of coal, in excess of the *entire production* of Belgium.

Of the 455,035 tons of Pig Iron produced in Belgium in 1865, about 370,000 tons were destined to be converted into manufactured Iron (the remainder being of a quality suitable for the foundry), and 276,277 tons of Wrought Iron were actually produced.

The wages of the Ironworkers are about equal to those of South Wales, but lower than those of any other part of the United Kingdom.

I am unable to compare this production usefully with that of the United Kingdom, as I do not consider the statistics of the production of Wrought Iron in England reliable, but it is possible to compare the *Exports* from the two countries.

Exports from Belgium of Iron and Iron-manufactures:—

	1864.	1865.	Ten months of 1866.
Total . . .	180,870	136,360	87,771

Showing a gradual decline in the Export of Iron from Belgium.

Taking the Exportation of rails, bars, &c., exclusive of Pig Iron or Castings, the result is similar.

Exports from Belgium of Malleable Iron:—

	1864.	1865.	Ten months of 1866.
Tons	148,530	125,649	74,693

And it may here be remarked, with reference to a contract for 40,000 tons of rails which it was reported would be given to the Belgian works, that the greater portion, if not the whole, has been actually taken by British manufacturers.

Turning now to the Exports of Iron from the United Kingdom we have in—

	1864.	1865.	1866.
Tons	1,476,130	1,593,632	1,647.345

showing an increase on each year, including the last, notwithstanding the derangements of various kinds which affected the Iron trade in 1866. The British quantities are *exclusive* of castings, &c., which are *included* in the Belgian figures.*

It has been stated further that Belgian and French Iron is being largely used in England. The Belgian Returns show that the Export of Iron from Belgium to the United Kingdom was—

	1865.	Ten months of 1866.
Tons	14,193	1,817

and the total Export of Iron manufactured in France to *all countries* in the first eleven months of 1866, was 2,494 tons; so that it is needless to inquire what proportion of French iron came to this country.

N.B.—*The entire Export of Iron from France in the eleven months was* 37,578 *tons, but the whole of this quantity, except the above* 2,494, *consisted of foreign Iron.*

I have not been able to obtain any return of the imports of Foreign Machinery into the United Kingdom (Mr. Laird, M.P., has moved for a return of the quantities), but the *Exports* were as follows:—

	Declared Value.		
	1864.	1865.	1866.
Steam Engines . .	£1,617,117	£1,958,533	£1,750,492
Other sorts	£3,231,475	£3,264,100	£2,998,692

This slight falling off in 1866 is accounted for, as the detailed figures show, by an almost entire cessation of a large temporary demand for Egypt, and by a diminution of exports to Germany and Spain, arising in each case from obvious causes.

It may be useful to add, that we *exported* to Belgium in 1866 (partly, no doubt, in transit to Germany) machinery of the declared value of 151,297*l.*

It is unnecessary to offer any comment on these figures, as establishing the relative position of the iron manufacture in the two countries; but on the other hand, I would direct attention to the fact, that the exports of *machinery* to Belgium have, in the last five years, consisted chiefly of that used in spinning woollen and

* There is a considerable and increasing export of iron from the United Kingdom to Belgium, but it is included in the Board of Trade returns in that to "other countries," and not much information could be derived if it were published separately, inasmuch as a portion is iron *in transitu* to Germany.

worsted yarns, which, coupled with this other fact, that we *imported* during the first eleven months of 1866, *woollen manufactures* valued at 1,702,569*l.*, is suggestive of competition in a branch of industry different from that to which public attention has been drawn.*

VII. MANCHESTER: ITS SANITARY AND SOCIAL STATE, AND ITS CORPORATE RULERS.

By George Greaves, Consulting Medical Officer, Chorlton Union Hospital, &c.

The increased attention happily paid, during the last quarter of a century, to sanitary science, beside adding greatly to our knowledge of the subject, has led to extended and more stringent legislation in reference to it. How the authorities intrusted with the care of the Public Health have used the increased knowledge and greater powers thus placed at their disposal, was shown to some extent in an article in a recent number of this Journal. The subject was, however, by no means exhausted; and it is one of such transcendent importance, that no apology can be necessary for recurring to it, unpleasant, and derogatory to our national pride as it is. In the ensuing remarks the inquiry will be limited to Manchester, because it is believed that, whatever be the shortcomings of the civic rulers of other places, nowhere are the laws of health more systematically violated than in Manchester by those whose special duty it is to obey them.

The metropolis of the manufacturing district has for years disputed with its chief seaport the bad distinction of being the most unhealthy town in Great Britain. In some recent weeks its death-rate has been higher than that of Liverpool. As the rate has been calculated for the whole city, including suburban districts almost as favourably circumstanced for health as many small country-towns, the mortality in other districts must necessarily be enormous. It has, in fact, recently been shown that in some of them the deaths have occasionally exceeded the births.

* The comparative statements relating to the manufacture of iron in this country and in Belgium, are founded chiefly on statistics recorded in the Trade returns of the two countries, in the reports of our legation at Brussels, and the publications and archives of the Keeper of Mining Records, supplemented, in a few instances, by information obtained from authentic private sources. To Mr. Robert Hunt, F.R.S., the Keeper of the Records referred to, and to the other gentlemen to whom I am indebted for assistance, my obligation is cordially acknowledged. 1,000 kilogrammes have been taken by me as being equal to a ton.

To what is this excessive mortality due? Not certainly to natural causes. The climate is equal to that of any north-western town. There is a good deal of rain, but this washes the streets, flushes the sewers, and sinks rapidly into the subsoil, which is chiefly sand or gravel, or new red sandstone. Although some portions of the surface are flat, there is sufficient elevation to allow of drainage.

Manchester is also plentifully supplied with water. It stands at the junction, with the Irwell, of the Irk and Medlock, and there are several minor streams which run either into one of these or direct into the Irwell. There is also an abundance of springs. But the rivers and brooks have for many years been mere sewers, and the spring-water, contaminated as it is, by a cause presently to be referred to, with putrescent organic matter, has long since ceased to be fit for use.

Early in the century some waterworks were established in this immediate neighbourhood, but, with the increase of population, the supply thus furnished soon fell short of the demand, and twenty years since Manchester was, in respect of its supplies of pure water, probably in as deplorable a condition as any town in Europe. In this emergency, the Corporation, under the able guidance of their engineer, Mr. Bateman, projected, and at great expense carried to completion, an extensive system of artificial lakes, to be filled by the rain-water flowing from many square miles of heathy surface on the hills dividing Lancashire from Derbyshire and Yorkshire. To the abundant supply of pure water thus furnished must, doubtless, be ascribed the almost total immunity of Manchester from the cholera in its two last visitations, as compared with the extreme prevalence and fatality of the disease in 1832 and 1849. For this magnificent boon, which has made Manchester the envy of every other town in England, the Corporation deserved our warmest thanks. Unfortunately, in carrying out the scheme, they seem to have exhausted all their sanitary zeal and energy, and have been content to live on the credit thus acquired. But the fund of reputation, although large, was not inexhaustible. It is well-nigh, if not altogether, exhausted, and if the municipal authorities wish to regain the position they once held in the estimation of their fellow-citizens and of the public at large, they must arouse themselves to renewed, and even more gigantic, exertions.

If, in spite of the possession of such natural and acquired sanitary advantages, the unhealthiness of Manchester is so great, there must be some forces at work to counteract them. What those are will now be shown. It will be proved that the Corporation have done and are doing their utmost to neutralize the benefits conferred upon us by their magnificent waterworks. They have given us pure water, but have denied us pure air.

There are two ways in which the atmosphere of a great city may be made impure. One is by the products of the combustion of coal; the other is by the emanations from decomposing organic matter. In reference to the first of these, the Corporation do not do nearly all in their power; but the smoke nuisance will never be reduced to a minimum until the public at large burn their coal in a less wasteful manner. The other nuisance exists in full force, not only unchecked by the authorities, but to a great extent created by them. If it had been wished to invent a method by which the atmosphere of a town should be as highly as possible charged with the emanations from putrescent human and animal excrement, and other organic refuse, it could not, in its offensive and deleterious character, exceed the mode of dealing with such matters in favour with the Corporation of Manchester.

The various modes of treating the nightsoil of a large town, which, in the discussions of the last few years, have been recognized as consistent with the slightest regard for decency or health, may be reduced to two; the one is the prompt removal of the *excreta*, solid and fluid, to the greatest possible distance from the houses, by means of water; the other, the retention of them for a limited time, in such a manner as to be as inoffensive and innoxious as possible, and their removal by a method equally safe and inoffensive. In other words, there are the wet and the dry systems.

The method which in Manchester has been allowed to become a time-honoured institution, is neither of these, but a foul and disgusting combination of the two, having the evils of both, and the advantages of neither. It is the MIDDEN SYSTEM.

A "midden," or "ashpit," as it is now thought more euphonious to call it, is an oblong pit sunk into the ground to the depth of some five feet, and bounded on three sides by a wall, and on the fourth side by the privy, to which it forms the receptacle; it is, in fact, strictly a cesspool, excepting that, in addition to the excrementitious matter, and all kinds of domestic refuse, it receives the ashes from the fires. The pits are open to the sky, except the part which is under the seat of the privy, and excepting also the instances in which both privy and ashpit are placed between two contiguous houses, in which case they are under the floor of an upper room. The pits are lined with brickwork, and have usually a flooring of brick or flags. In one of the side-walls is an opening, through which the ashes are introduced, and through which the pit is emptied. There is, with very few exceptions, no provision for causing the ashes to fall upon and cover the *excreta*. Consequently the two matters form separate heaps, which, as the receptacle becomes full, gradually coalesce, but never commingle, except under the spade of the nightsoil-man. The deodorizing and antiseptic properties of dry ashes are thus not availed of.

The rain, so abundant here, falling upon the ashes, is by them conducted to the feculent matter, of which the rapid decomposition is further promoted by the position of these conveniences. In an immense proportion of the smaller houses, in all, in short, of those more recently built, the ashpit is in contact with the wall of the house, and its fecal contents thus receive the heat from the house-fires; or, as in an instance recently made public, they may have the benefit of the heat from some adjacent furnace. Most of the ashpits are now drained, but the opening of the drain is not in every instance on a level with the floor of the pit, but several inches above it; and where level with the floor, it is liable to be choked by the ashes or other matters, and consequently the water often stands in the pits to the depth of several inches, or even a foot or two. As the pits are in no case water-tight, their fluid contents often percolate the wall of the house, and enter the cellar where the people keep their food, and even the ground-floor rooms in which they cook and eat their meals. What the fluid is, and what the exhalations from it, need not be said. To prevent this annoyance, the people sometimes make a hole in the outer wall of the ashpit, which allows the water to flow out into the entry behind. Another portion of the water passes through the floor, and sinks into the subsoil. No wonder, therefore, that pump-water in Manchester and the neighbourhood has long been unfit for use. The underlying strata are a reservoir of a solution, ever becoming more and more concentrated, of the compounds resulting from the decomposition of human excrementitious matter. The city stands over one vast secondary cesspool. That it will some time make its presence felt, far more even than now—that the Nemesis of the violated laws of health will one day arise in her strength, and, possibly by some new form of pestilence, sweep from the earth by thousands a people so reckless and infatuated, who that has considered the subject can doubt? Even our vaunted water-supply may fail us. The water-pipes, however strong, will not for ever withstand the perpetual action of the fluid by which they are externally bathed. They are not always full. Inward leakage from the surrounding earth may take place, and the water, which flows from the hills so pure, may then enter our houses charged with poisonous elements. That this is no imaginary danger is proved by what has sometimes occurred in London. There the gas, escaping from the mains, has made its way into the water-pipes, and a light applied to a tap has caused it to emit flame. Do such thoughts as these never trouble the repose of our rulers? or, imitating a late famous statesman, do they say, "It will last our time, *après nous* LA PESTE?"

But what becomes of the portion of the rain-water, entering the pits, which neither leaks through into the houses, sinks into the

earth, nor is carried off by evaporation? It enters the sewers, and is by them conveyed to the rivers or smaller streams, the main drains of Manchester. Of these the smaller, such as the Tib, Shooter's-Brook, and the Corn-Brook, are, during the greater part of their course, arched over, and as, in common with the artificial sewers, these natural ones are never* flushed except by the rain, and as none of either class is ventilated, the gases generated in them frequently enter the houses, unless there be most careful trapping. The consequence of this was recently very forcibly shown. A portion of the Corn-Brook, about a quarter of a mile in length, had, until last summer, remained open. It was covered in, and in the course of a few weeks several cases of typhoid fever, and some of obstinate diarrhœa, appeared in the neighbouring houses.

The rivers, beside the fluid drained from the ashpits, receive the sewage from the comparatively few water-closets, and from the public urinals, as well as from the slaughterhouses, pigsties, and manufactories of all kinds, including the gasworks. Of the compound thus formed no description will convey an accurate conception. It must be seen and smelt. And were it rapidly carried off the evil might be less. But it is not; the movement of the water, always necessarily slow, from the winding course of the streams, is still further impeded by weirs, which cause the more bulky solid portions of the sewage to be deposited.

And now what becomes of the solid contents of the middens? In the middle of every night gangs of men, each provided with a cart and a wheelbarrow, turn out, and before morning empty a certain number of the pits. This work is done at irregular times, and apparently with very little system. Much depends on the rate at which the pits become full, much on the urgency and frequency of the messages to the nightsoil department, something also on the social position of the individual householders, and their ability to make their complaints of inattention heard, or, it is even said, their willingness to "tip" the nightsoil men.

As this work is done in the night-time, the people, unless they chance to be awake, are not conscious of it. But they are reminded of it in the morning. The soil is conveyed by wheelbarrows, along the passages which run between the rows of houses, into the nearest street, is there laid upon the pavement, where it undergoes a process of sorting, by which what is likely to be useful as manure is separated from the broken pots, coarser cinders, and other rubbish. The "manure" is carefully removed in carts; the "rubbish" is sometimes to be seen lying in the street in the middle of the forenoon, with, of course, much of the manure adhering to it. But

* Until within the last few years the sewers were ventilated by grated openings in the streets; stench-traps have, however, been substituted, with, of course, the effect of driving the gases generated into the houses.

even when that is removed, much that is offensive remains behind. The droppings from the wheelbarrows are visible in the entries, and the place in the street where the nightsoil has lain is discoverable by more than one sense until the next shower of rain falls, or until some tidy housekeeper, not yet habituated to Manchester usages, sends her servant, with sundry bucketfuls of water, to wash away the filthy deposit. The servants of the Corporation never do this, nor do they in the slightest degree cleanse the pits after emptying them.

The stuff thus removed having lost, while lying in the pits, a great part of its volatile and soluble elements, has comparatively little manurial value. Some time since its depreciation had become so great that the farmers would scarcely accept it as a gift. A notable expedient was hit upon. It was to collect the offal and refuse from the various slaughterhouses, to convey it to the nightsoil depôts, and then mix it with the soil. The depôts are all within the city, and, as was said in a former article, the Corporation have purchased the neighbouring houses. They need not fear complaints from their own tenants. In one of those houses four cases of fever recently occurred. It should be added that in no instance is any attempt made, by the use of a deodorizing chemical preparation, to lessen the horrid stench produced in the process of emptying the middens, or that of manufacturing the manure. Perhaps it is feared that if the manure were inodorous the farmers would not buy it.

Another mode in which the atmosphere of Manchester is made impure is due to the uncleanly habits of some of the people. In some of the worst districts it is too common to find the conveniences themselves, and the ground near them, defiled by deposits of feculent matter. Nor ought the people to be very much blamed for this. By the midden system they have been untaught the rules of cleanliness and modesty which nature teaches. Permitted, as they have been, to grow up in the midst of all that is abominable, they have learnt to tolerate it. A further excuse for the uncleanly practices of these poor people is that they are often forced into them by the want of the means of being cleanly. In a court containing fifty or seventy inhabitants, it is usual to find only two conveniences, and sometimes one, or even both of those, has been found in so ruinous a condition as to be unfit for use. In one of a series of reports made last May by the medical officers of the Chorlton Union, on the sanitary state of their respective districts, this statement appears:—

"In an area of 3,000 square yards in No. 3 District, Hulme, stand 106 habitations; of these 33 are cellar-dwellings, of which nine consist of only one room. The rest have two. In the 106 dwellings there are 154 families, consisting of 546 individuals. For

that number of persons there are 26 privies but of these six only are fit for use, one to every 91 individuals." We cannot wonder that, as the report adds, "The streets are generally in a filthy condition, being swept only once a week."

There being in Manchester 50,000 ashpits, the foul emanations from them more or less pervade the whole city; but they are, of course, most abundant in such districts as that just described. In those districts, also, they are made more deleterious by the construction and arrangement of the dwellings of the people. These are such as almost entirely to prevent the dilution and removal, by the winds of heaven, of the noxious effluvia, and to retain them, in their most concentrated form, in and around the houses. Allusion has already been made to cellar dwellings. Of these there were, in 1860, 4,467 inhabited by 17,478 persons. The number has probably since been rather reduced, but with the effect of still more overcrowding those which remain. Next are the back-to-back houses. These are tenements consisting usually of two rooms, having the door and windows on one side, and therefore not allowing through-currents of air. In the rear of each such abode is another, similarly constructed, and hence the name. Of such houses as these, there are thousands in Manchester. The erection of any more of them is forbidden by a local act. But the law is evaded. Many houses, previously having rooms to the back and front, have, within the last few years, been converted into back-to-back tenements.

These abodes are further made worse by their position. An immense proportion, if not all, of the back-to-back houses stand in courts, having only one entrance, placed usually at one end, but sometimes at the side. Each court has its ashpit, with one or two public conveniences, situated usually at the end opposite to the entrance. An instance can, however, be shown in the township of Hulme, in which an ashpit stands on each side of the entrance into a court containing about a dozen houses. Every breath of air, therefore, which enters the court in a horizontal direction, comes poisoned with the effluvia from the ashpits. Such places as these are veritable stench-traps, with an inverted action. And they are fever-traps also. In the particular court just described, a number of cases of fever occurred in the course of last winter. Such was the intensity of the poison, that one young woman having, after her recovery in the union hospital, gone back to the same house, took the disease a second, and a *third* time, and after all recovered; perhaps an unique instance. In another court in the same neighbourhood, thirteen cases of fever occurred in one house. In another house, having its back entrance into the same court, were, last autumn, four fatal cases of cholera, almost the only genuine cases which occurred in Hulme.

Each court usually contains from eight to a dozen houses. But

instances are to be found in which a court contains only one house. Such a court in Chorlton-upon-Medlock has lately been described by the writer, in the following terms:—

"It is a back-to-back cottage, having no window or door at the back, but a side window overlooking the Medlock. It stands in a court ten feet square. The house itself forms one side of the court, opposite to it is a slaughter-house, on the right is the back of the next house, with the narrow entrance from the street, and on the left is a dead wall, under which is placed a privy and ash-pit. Behind the wall flows, or rather stagnates, the Medlock. The flagged floor of the court, which is nearly a foot below the level of the street, is broken and uneven, and shows signs of imperfect drainage. The house consists of three rooms, each ten feet square, and nine in height, and is very dirty."

That in such a cabin, placed in such a well, with such surroundings, ashpit, slaughterhouse, and an open sewer like the Medlock, fever made its appearance, can surprise no one. The whole of the family, consisting of nine persons, had it in succession.

In reference to the homes of the people, some painfully interesting information has lately been published by the Manchester Statistical Society. It is contained in the report of a sub-committee appointed in 1865, to inquire into the social condition of two districts, not by any means the worst in Manchester.

A portion of the information given as to one of these districts, may thus be summarized. First, as to the density of the population. The area of the district being 57,000 square yards, and the population 3,316, there were about 177,403 to the square mile. The number of inhabited houses was 607, 68 of which had cellars let out as separate tenements. The number of families was 789, occupying 1,805 rooms, an average of 2·29 rooms to each family. But 151 of these families, consisting each of five, six, and even seven persons, were found to be living each only in one room. The houses are described as being very dirty. Of the 607 houses 398 are back-to-back tenements, having therefore no ventilation. Many of the privies are said to be very much exposed, and the stench from them to be a great nuisance. In one case twelve families have to make use of one privy, "*and that is closed every evening at ten o'clock by the person who keeps the key.*" Dogs are kept in great numbers. Ponies and donkeys were found in the very houses. One man had two small horses in his kitchen; another a pony and a pig in his scullery, and rabbits and dogs in other parts of the house. In one of the courts there were five donkeys kept. The state of the houses as to uncleanliness may be imagined. "Indeed," says the report, "very many of the habitations in this district are in such a condition, partly from the filthiness of the inhabitants, and partly from the smell of privies, drains, and

animals, and the dampness of the walls, and, in some cases, the ruinous condition of the buildings, as to be almost intolerable and wholly unfit for human dwellings. In some cases the smells were so bad, that the visitor could not remain in the house, and was forced to call the people out, to obtain the desired information. Some of the houses have almost fallen down, and the inhabitants pay no rent. The state of the gutters and drains is, in some of the streets, very unsatisfactory."

As to the appearance of the people; out of the 789 families, 118 are described as "dirty and untidy;" and 168 as "very filthy indeed." The children and even the women were almost naked. In several instances the children were entirely so, and "eating their food out of a pan in the middle of the floor like so many pigs."

And yet a very large proportion of these people were found to be in the receipt of incomes, which, properly husbanded, would enable them to live in comfort. But most of the money goes to the public house.

Do not such facts as these, added to others which have lately been made known in reference to the want of education, justify the assertion that if there be a condition which can be described as one of retrograde civilization, it is that of a large number of the inhabitants of Manchester?

To return, however, to their sanitary condition. It has been abundantly proved, both that the sources of atmospheric contamination exist to an enormous extent, and that the existing arrangements of the buildings in large portions of the city are such as to retain the noxious exhalations in and around the habitations of the people, to infect their food, their drink, and their clothing, and to be inspired with every breath they draw. No wonder that the diseases, chronic and acute, produced by a poisoned atmosphere, are so rife, that the mortality, especially of the younger children, is so enormous, and moreover that almost all the cases of continued fever have occurred in those neighbourhoods. If cholera has lately been absent, it has been because, to the curse of foul air, that of impure water has not been added. Diarrhœa, during the last autumn was exceedingly prevalent, but it was almost entirely limited to districts such as have just been described.

One very interesting and important fact in reference to the type of fever which has recently prevailed in Manchester ought not to be omitted. Although well-marked instances of pure Typhus have not been wanting, as well as of pure Enteric or Typhoid Fever, a large proportion of the cases have been a mixture of the two, the characteristic signs of one or the other predominating in different cases.

This hybrid character of the disease is easily explicable by its

double mode of causation. The effluvia from living human bodies, when concentrated, and those also probably from recent excrement, generate Typhus, while Typhoid fever is produced by the emanations from decomposing animal matters. It has been shown that in the fever-haunts of Manchester, both these causes are in operation.

It has thus been shown how the Corporation of Manchester have performed the duty of removing the predisposing causes of disease. Let us now see what they have done in the actual presence of disease, fostered by their own negligence. During the last three years, continued fever has been epidemic in Manchester, and although during the winter just passed away, it has not been quite so prevalent as in the previous one, yet for many weeks in succession, the weekly average of new cases under public treatment has not been less than eighty, to which must be added nearly as many more met with in private practice.*

It might, therefore, have been expected that the municipal authorities would be on the alert, especially since their acquisition of increased powers and greater responsibilities under the Sanitary Act of 1866. How have they acted in these altered circumstances? Let one instance answer the question.

Early in December last, fever broke out in a house situated in Riga Street, a short and rather narrow street in the older part of Hulme. The whole family, consisting of six persons, were removed to the Chorlton Union hospital. Three days after the removal of the last of them, the house was visited by the writer of this article. He found the house closely shut up, and there was no evidence of any attempt to cleanse or disinfect it. It was excessively dirty, the floors and walls almost black with filth. The only furniture to be seen was an old straw palliasse, and a quantity of cotton flocks, lying loose in a corner of one of the two bed-rooms. The remainder of the furniture had been taken under a distraint for rent, *after the fever had made its appearance in the house.* It had, of course, been taken to a broker's shop, and the various articles, impregnated as they were with the poison of typhus, had most probably been sold, and the infection thus spread abroad through the city. Three days later, the house was in the same unpurified state, excepting that the windows had, at the suggestion of the writer, been left open. These facts were reported to the Chorlton guardians, at their meeting on January 4th, and a copy of the

* From the weekly returns of the Sanitary Association, it appears that in the eight weeks ending February 23rd of this year, 660 new cases of fever occurred in public practice in Manchester and Salford, an average of 83 per week. In the same period in 1866 the number was 1049, or 131 weekly. The deaths in the two periods respectively were 137 and 200. The people of the two towns were therefore, in the first two months of the present year, dying at the rate of nearly 900 per annum of a disease which ought not to exist, and those who so died were the most valuable members of society.

report was ordered to be sent to the Town Clerk of Manchester. On Monday, the 7th, an inspector visited the house, and instructed the owner, or his agent, to have the house cleansed and disinfected before admitting fresh tenants. Nothing was done until the 10th, when two men set to work, and by the afternoon of the next day, had lime-washed the ceilings and the walls of the two upper rooms.

By that time, also, some fresh tenants had arrived. A very respectable-looking woman, with four little children, was found sitting, with a look of dismay, in the midst of a quantity of very good and clean furniture, bed-stocks, bedding, &c., which she had brought ten miles out of the country, and which was lying on the filthy floor of the sitting-room, and resting against the infected wall-paper. The palliasse found in the house when first visited had disappeared. It had probably been taken away, and sold for what it would fetch. The cotton-flocks on which some of the fever-stricken family had lain until their removal to the hospital, being unsaleable, had, without any attempt at disinfection, been thrown into the ash-pit, common to the fever-house and several neighbouring houses. Verily, the Nuisance Authority in Manchester has solved the problem, how *not* to do it. The publication in the local newspapers of the above facts, caused a little stir among the dry bones. The discovery was made that the 22nd section of the Sanitary Act, 1866, made it the duty of the Nuisance Authority, after obtaining the certificate of a medical practitioner, to disinfect such houses, provided it was not done by their owners. The City Council furnished the different Boards of Guardians in Manchester with blank forms of such certificate, with the request that when necessary they might be filled up by their medical officers.

Any one, it appears, but those whose duty it is by Act of Parliament, may perform the functions of the Nuisance Authority in Manchester.

Those who have heard or read the speeches recently made by the advocates of the Corporation, in Manchester or elsewhere, may be inclined to think that in some of the foregoing remarks they have been unfairly dealt with. With an air of injured innocence which would be amusing if the subject were not too serious, they have gone about representing themselves as cruelly persecuted by the "Theorizing Sanitary Reformers" because they are not prepared, at the bidding of a section only of those gentlemen, to abolish the dry-closet system which has grown up in Manchester, and substitute for it that of water-closets. They thus hope to avail themselves of the dissensions among their critics as an excuse for doing nothing. But as has been shown, it is an utter perversion of language to call the system established in Manchester the dry system, and the implied state of hesitation does not exist. In the minds of our *real*

rulers the question is decided. The decree has gone forth that if by any means it can be prevented, water-closets shall not be substituted for privies and ashpits. An attempt at prevention, by laying an extra rate on water-closets, was defeated by the decision of a Committee of the House of Commons so long since as 1858. The compulsory re-conversion of the comparatively few water-closets into privies, is now being attempted by an illegal tax for removing the dry ashes.

Such being the determination of the authorities, ought they not at least to endeavour to make the middens inoffensive? The modes of doing this,—of to some extent converting them into dry closets,—have been urged upon the council again and again, but with the sole effect of causing them, in some new by-laws recently published, to order that in all new houses the ashpits shall be roofed over, and their contents kept dry. But these by-laws apply only to future constructions. The fifty thousand ashpits previously existing are to be left in their pristine condition of barbarism; no change is to be made in the mode of emptying them; the manufacture of manure at the nightsoil depôts is to go on unchecked, and the depôts are to remain within the city. And if the sources of atmospheric contamination are to remain, the impediments to the removal by currents of fresh air of the polluted atmosphere are also to continue. One of the new by-laws enacts that if any building erected since June, 1865, shall be declared on competent authority to be unfit for human habitation, it shall be shut up until rendered fit. None of the thousands of houses erected before that date, which are unfit for human habitation, are to be closed; nor are the confined courts in which they stand to be opened to the winds of heaven. The new by-laws will therefore have as much effect on the monster nuisance of Manchester as a teacupful of water on a raging conflagration.

VIII. THE ARTIZANS' AND LABOURERS' DWELLINGS BILL.*

All sections of the governing body of the state, with the exception of a few gentlemen who can hardly be said to belong to the present generation, are agreed upon the necessity of extending the elective franchise to a vast number of artizans and labourers from whom it has hitherto been withheld; and concurrently with this national

* "Artizans' and Labourers' Dwellings." A Bill to provide better Dwellings for Artizans and Labourers. Prepared and brought in by Mr. M'Cullagh Torrens, Mr. Kinnaird, and Mr. Locke. Ordered by the House of Commons to be printed, 12th February, 1867.

action, all possible means are being taken by the representatives of the people to prepare the future electors for their privileges, by raising their mental intelligence, as well as their physical condition.

Two phases of legislative activity present themselves prominently to the observer of social affairs; the one (hardly yet commenced) is compulsory education, and generally the extension of education amongst the masses; the other, compulsory obedience to social and sanitary laws.

When we say that there are thousands of electors living in houses, in which it is absolutely impossible that their bodies, much less their minds, can be maintained in healthy action, and that there are tens of thousands still unenfranchised who dwell in hovels compared with which the huts in some of M. du Chaillu's Ashango villages must be palaces, we are only re-stating facts which are revealed in every page of history; and to the man of science, the most hopeful feature in the present political crisis is that the privilege of electoral power cannot fail to be accompanied by a sense of pride which will stimulate its possessors to improve their own social condition; and in one respect there is an advantage in the work of Parliamentary Reform being undertaken by the Conservatives. It is they who have always sought to withhold the franchise from the masses, because they considered them unfitted to receive it; and therefore, unless they mean to belie their first principles, and to leave it in the power of their adversaries to taunt them with insincerity, and with a desire to keep the people in a state of vassalage, they must not only raise them in the political, but also in the social, scale.

Whatever may hitherto have been the opinions of men in regard to political enfranchisement—that is to say, whether they have thought the people should be improved before they were permitted to have a voice in the government of the country, or that they should be at once allowed to vote for such representatives as they presume to have their interests at heart in a superior degree to those in whose election they have had no voice—one thing is quite certain, namely, that their social condition should be improved, and that all political and religious denominations should join earnestly and disinterestedly in the noble work of social and intellectual enfranchisement.

We must, on this great question, utter no uncertain sound.

It is *we* who are answerable for the degraded condition of those fellow-citizens whom we pronounce to be unfitted for the elective franchise. It is vain for representative bodies, local or imperial, to say that the drunkenness, uncleanliness, or poverty of the people is their own fault, and they must be made to suffer the consequences. Such statements are simply admissions of ignorance, incapacity, and unfitness for office, on the part of those who make them; and the

sooner the aspirants for political power acknowledge the responsibilities and duties of their position, and follow up the admission by energetic action, the better will it be for the nation.

Mr. Torrens and his colleagues, who have introduced the Artizans' Dwellings Bill (an enactment which it is only right to say, is based upon the Liverpool Sanitary Amendment Act of 1864, framed by Mr. W. T. McGowen, formerly Liverpool Law Clerk, now Town Clerk of Bradford; Mr. Shuttleworth, Ex-Town Clerk; and Mr. James Newlands, the present Borough Engineer of Liverpool*), deserve well of the community; and there is no doubt that whatever may be the present decision of the House of Commons on the question of Parliamentary Reform, there will be no difference of opinion as to the desirability of carrying, as speedily as possible, this beneficent enactment.

The process by which the Bill proposes to improve the dwellings of the humbler classes is simple and efficacious, and the only influences which can militate against its usefulness are those which may arise where the members of Corporations are corrupt, and the officials afflicted with the same weakness, or with the desire to please and serve their patrons at any hazard. Every borough must have an officer of health; every officer of health must report to juries what houses, streets, or courts are unfit for human habitation, and how they should be dealt with; whether only structural alterations are necessary, or whether total demolition is the sole alternative. Upon such reports the jury must instruct the municipal authority to act. This they will do either by allowing the owner of the "presented" property to deal with it himself according to their instructions, or, should he be unwilling to do so, and should total demolition be necessary, they must then agree with him as to terms, and purchase the property out and out.

In addition to these powers, the Bill also authorizes loans of money at a low rate of interest by the Public Works Loan Commissioners to Corporations wishful to build dwellings for such families as are likely to be turned out by the operation of the Bill; so there will in future be no justification whatever for any local governing body, whether it be of the smallest village or of the largest overcrowded commercial or manufacturing centre, if such abominable nests and rookeries as now exist, should in future be found within its jurisdiction.

But although we have expressed the conviction that all political parties will unite in passing the Bill, we are not quite so certain that it will meet with no opposition on the part of those whom it is intended to benefit the most; and such of our

* Mr. Hugh Shimmin, of Liverpool, who had written some valuable articles on the state of the courts there, was a material witness in securing the passage of the Bill.

readers as remember what was stated in a former number of this Journal,* namely, that the Corporation of Manchester, leagued with some neighbouring municipalities, obstructed the passage of the Sanitary Act of 1866, will not be surprised to hear that the boasted metropolis of the north is pursuing a similar course with regard to the present Bill.

The objection we hear raised to it in that quarter is that it will enhance the value of dilapidated tenements, and that landlords will neglect their property in order to compel the Corporation to purchase it. For the benefit of some of our landed gentlemen, who are not supposed to penetrate the municipal secrets of our large towns, we may explain that when a wealthy Corporation like that of Manchester raises such an objection to the expenditure of money in the way described, for ameliorating the condition of its working population, it has some grounds for so doing, inasmuch as landlords —aye, rich landlords—in large towns often *do* take advantage of "Improvement Acts" to sell their property to Corporations at an exorbitant price; but in this case the sinners are likely to be poor people who own a house or two in a court, and who possess little or no influence in municipal elections. The rapacity of such people must not be encouraged, even if the alternative be that Manchester (or some other larger town) shall remain what our uninitiated readers will find it to be if they will take the trouble to peruse the article on its present condition, in another portion of this Number.†

Shame on you, men of Manchester, who have amassed your fortunes by the sweat, not of your own brows, but by that of the hardy sons of toil to whom you would now deny even decent habitations! Would that the shade of Richard Cobden could rise, that he might point the finger of scorn at his successors who deny the fresh air of heaven to those upon whom he conferred the boon of cheap bread! We have little fear of the result of such opposition; it will recoil upon the opponents of the Bill, and it is but just to the citizens of Manchester to say that, as far as we have been able to ascertain, the municipal authorities do not in this, nor in any other sanitary obstructions, represent their true feelings and desires.

But the Bill is not without drawbacks, and one of these deserves attention. We think it gives too much power over the public moneys to an almost irresponsible public official, the Medical Officer of Health. We strongly recommend the addition, in committee, of a restrictive clause similar to the 49th clause of the Sanitary Act of 1866, which enables the Home Secretary to act upon the well-founded complaints of inhabitants, and we are not sure that it would not be better in the very first instance to divide the responsibility of making

* "The Public Health," 'Quarterly Journal of Science,' Oct. 1, 1866, p. 496, on the Sanitary Condition of Manchester.

† On "Manchester: its Sanitary and Social State, and its Corporate Rulers."

presentments, for, whatever may be the theory of the Bill, in practice the mode of its execution will rest entirely with one official, who, however honest he may be himself, may not always find it easy to resist the importunity of those upon whom his material interests are dependent.

These are, however, matters to be regulated in committee, and as regards the Bill itself, we can only repeat that its passage will be, in our opinion, an event of far greater importance than that still important one, the passing of a new Reform Bill.

The latter is a measure which will only be useful in so far as it enables the newly enfranchised to appoint as their representatives men who will feel a deep interest in, and will promote, their welfare; whilst the former will in a brief space of time raise masses of degraded beings, even then unenfranchised, from the status of mere animals living and following their instincts in localities hardly to be called houses, in which, if they were compelled to live, many of the lower animals would soon become etiolated and would miserably perish. There, at present, men and women live and die herded together without any acquaintance with the decencies of civilized life, seeking refuge from the tainted atmosphere of their wretched homes in the gorgeous gin palaces that stand invitingly open to receive them, and there their children are allowed to run riot, surrounded by every condition necessary to breed thieves, vagabonds, and prostitutes.

Will this be any longer tolerated in Britain? We hope not; we look for a brighter day, not far distant, when the wealthier classes of the community will, with one accord, acknowledge their obligation to provide habitable dwellings for their poorer citizens, and so give them an opportunity of acquiring the much-needed habits of modesty, sobriety, and cleanliness, and a sense of self-respect without which no one can be considered a member of a civilized community.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

At length, after twenty months of a disastrous experience, we can report a week of entire freedom from the Cattle Plague. During the week ending March 2nd, no case was reported at Whitehall; and it only needs three weeks' continuance of this good fortune, and (excepting our liability to the reimportation of the poison) we may hope that we shall have finally got rid of the disease. That the infection is as virulent as ever when it occurs, appears, however, in the recent experience at Islington, where Mrs. Nicholl's herd was a second time attacked. The plague first appeared here in June, 1866, ran through the sheds, and spread throughout the country: it reappeared in February of this year, again ran through the herd, but was confined within the premises by the precautions which, not possible twenty months ago, are now enforced by law.

The President of the Royal Agricultural Society did well, in his Annual Address in December last, to insist upon the need of considering the disease as a conflagration; urging upon the Government that, just as the whole machinery of fire-engines and firemen is maintained where there is no fire, to extinguish it should it arise, so the existing machinery for stamping out the Cattle Plague should be maintained in readiness to deal with it, should it again attack us. The other points to which Mr. Thompson's address referred are also of first-rate agricultural importance, including the difficulties of the labour question, the need of developing those departments of farm practice which result in the production of animal food, and the call for an improved agricultural education. On the first of these topics he declared the impossibility of carrying out the so-called co-operative system in farm practice; recommending, however, as a much more likely expedient for retaining the existing agricultural labourers, that farmers generally should adopt what is already a common practice in some counties—the plan of either letting land to their labourers, or otherwise providing them with a cow's keep. A man who can ensure regular work at fair wages, with sufficient land to keep a cow and a pig, and obtain even a moderately good cottage among the friends and neighbours whom he has known from childhood, will seldom be found willing to change his position for the crowded courts and alleys of the large towns, even by the temptation of considerably

higher money wages. Add to these domestic advantages offered to married labourers a system of piecework payments, by which young men shall be remunerated according to the actual value of their services, and it is probable that the ranks of the agricultural labourer may not be so rapidly thinned as, to the great inconvenience and difficulty of the farmer, of late years, they have been. The increased supply of animal food—meat and milk—which was the next topic referred to in Mr. Thompson's address, is rapidly becoming a more important branch of English agriculture. Cattle food is being grown in larger quantity, not by the laying down of ploughed lands to permanent pasture so much as by the better cultivation of green crops on arable farms. Rotations of crops are altered to suit the demands for an increased live-stock. Two green crops are cultivated in succession, and clovers and grasses, taken in alternate husbandry, are kept down more years than one; and the smaller portion of each farm which may thus sometimes be devoted to corn-growing, yields, nevertheless, an increased quantity of grain, owing to the fertilizing effect of the larger flock of sheep or herd of cattle which is thus maintained.

An instructive paper "On the Application of Manures" was read by Dr. Voelcker before the London Farmers' Club in December, in which he argued for the immediate application of farmyard dung to the land, not on the ground that loss is incurred during fermentation in the dungheap, but because there is considerable loss of soluble substances during that process by the exposure of the dungheap to rain. The unprofitableness of the old-fashioned dungheap is alleged to be owing, not so much to evaporation, as to the washing effect of rains. There is as much actually of ammonia in the reduced mass of the rotten heap, as there was "potentially," to use Dr. Ure's phrase, in the original bulk of the fresh manure there hauled together. The recommendation to put the manure at once upon the land, even though it be autumn, and for a spring crop, is perhaps hardly safe on very light land, where the soil has less ability to retain the products of its slow decomposition. The remedy for the immense loss of fertilizing material, which takes place under the ordinary management of the dungheap, on such farms, is to adopt the plan of covered yards, where the manure is allowed to accumulate under shelter until it is carried out in the spring. Another urgent recommendation of the Professor's, in connection with the application of all kinds of manures, was to take care that they were thoroughly mixed with the soil. It is doubtless owing to the perfect distribution of their fertilizing matters through naturally fertile soils, that a good season is, on such soils, able to produce an excessive crop. And the aim should be, whether in applying bone-dust, guano, or nitrates, so to triturate, reduce, or dissolve them, that, after application, every portion of the land

through which a root can penetrate shall contain its share of the application ready as the food which that root requires.

The recent publication of the agricultural statistics collected by the Board of Trade does not materially alter the conclusions, to which students of that subject had already been led as to the actual and relative areas of the different crops cultivated in Great Britain. The wheat crop in England and Wales was formerly estimated at 3,800,000 acres, it is now declared to be 3,274,000. The total corn crops of the country occupied 7,920,000 acres in 1866, against 8,437,000 at which they were estimated in 1857. And the green crops (food for cattle, &c.) are put at 2,890,000 acres, against about 3,000,000 which was the estimate ten years ago. The area returned as permanent pasture now is 10,255,000; it was formerly estimated at 10,166,000 acres.

A clever pamphlet by Mr. Heywood, of Dunham Massey, Cheshire, points out to farmers that, as the cultivators of living plants and animals, they cannot do just what they please, as they might if they were the manufacturers or manipulators of merely dead material. Living creatures follow their own natural laws, and our efforts for the promotion of their health and productiveness must be obedient to their nature. Indeed, as stated in the 'Agricultural Gazette' when reviewing Mr. Heywood's pamphlet, the keeper of a living thing must be its most humble servant if it is to prosper in his hands. The nature of the creature, not the arbitrary will of its master, must determine the treatment it receives. And the fact that animals, and even plants, are not mere machines, capable of producing a double quantity of the manufactured article from a double quantity of the raw material supplied to them, rebukes a great deal of that exuberant and urgent, and often wild advice, which is frequently addressed to practical agriculturists by the amateur. They know by long experience the limits of this kind which are imposed by nature, and against which, or over which, no man ever went uninjured. Within those limits, however, it is the part of a wise and energetic man thoroughly to cultivate the field which is his own; and thus successful high farming consists in selecting animals and plants for cultivation which have great natural powers of assimilating food, and in treating them fully up to this their precocious nature.

The new organization of Chambers of Agriculture, to which reference has been made in previous Chronicles, has gradually developed during the past quarter. Such chambers now exist in almost all parts of the country, and there is a central institution in London professing to act as a common mouthpiece for them all, through which the voice of the agricultural world may be urged upon the Home Secretary, in connection with any amendment or enactment of law that is desired. The consideration of the Turn-

pike Trusts, with the maintenance of roads otherwise than by the outrageously expensive toll system, is the topic selected for their first attempts to move the government of the country. There are several other agricultural topics being urged in Parliament, which are equally deserving of attention with this; and they are being taken up by individual members in the House of Commons with great ability. Thus, Professor Fawcett urges the more general enforcement of the Factory Laws, which limit the hours of labour in the case of children under a certain age, and require them to attend school during certain hours of the day. Certainly the application of these laws to the case of children employed in the field would be very difficult, chiefly owing to the immense labour of inspection which would be necessary to see that they were duly carried out; but it cannot be doubted that compulsory education would ultimately be most beneficial in the agricultural districts, as elsewhere.

The severity and impolicy of the Game Laws is another topic which has lately been urged very effectively upon the House of Commons. And these and other topics of agricultural interest will, no doubt, form the subjects of discussion before the newly constituted Chambers of Agriculture throughout the country.

It will be our duty, in July, to report the place which agriculture has occupied in the great International Exhibition at Paris. The preparations for its due representation there are on the largest scale.

2. ARCHÆOLOGY AND ETHNOLOGY.

Mr. Engelhardt's important work, entitled 'Denmark in the Early Iron Age,' forms a worthy sequel to the publications which, treating of earlier epochs, we noticed in our last Chronicle. The Iron age of Denmark has been divided by Professor Worsaae into three periods: "the Early Iron age, from about 250 to 450 A.C.; the Transition period, extending to the close of the seventh century; and the Late Iron age, terminating with the introduction of Christianity about the year 1000." The Early Iron age commences with the introduction of three very important elements of civilization, in advance of those which characterized the Bronze age immediately preceding it. These are (1) the use of Iron; (2) the employment of horses for riding and driving; and (3) the possession of an alphabet of Runic letters.

A comparison of the antiquities belonging respectively to the Bronze and Early Iron ages exhibits very remarkable contrast, of which it will be desirable to mention a few. The weapons and cutting instruments of the Early Iron age were invariably made of iron, and present a high degree of finish: instead of the cast

bronze swords of the previous period we now have to deal with damascened and welded swords of iron. Bronze, or more properly brass, was, however, in use; but zinc was mixed with the copper instead of tin. The use of gold is common to the two periods; but silver, ivory, glass, agate, and porcelain beads appear to have made their first appearance during the Early Iron age. The ornamentation of the manufactured article differed very strikingly in the two periods: in the Bronze age it was geometrical, stiff, and monotonous; in the Early Iron age it consisted of heads and figures of animals, human figures, stars, pearls, &c., and not unfrequently of a religious device known as the fylfot. Boats of considerable size were built during this period, one found in Nydam Moss measuring seventy-seven feet in length. Roman antiquities have been found mixed up with those belonging to the inhabitants of Denmark at this period; but they rarely occur alone, and not a single Roman sepulchre has been met with.

Now, contrasting these characteristics of the two periods, it becomes an interesting question whether they lead to the inference that the transition from the Bronze to the Early Iron age was gradual: the result of an advancing civilization, and of peaceful intercourse with other nations; or whether they point to the conclusion that, at the termination of the Bronze period, Denmark was invaded by a more highly civilized people? Mr. Engelhardt discusses this question very clearly, and accepts the latter alternative. There is no connecting link between the swords of the Bronze and those of the Early Iron age; we have to do with "new ornaments as well as new materials, and a different composition and treatment of those formerly known." The artistic ornamentation does not indicate the infancy of art, and, what is remarkable, there is observable "a decline of art from its comparatively high development in the early period of the Iron age, to a much lower standard towards its conclusion, with regard to style and form, as well as to technical skill in metal-work." Then the sudden appearance of horses, already domesticated, and the equally sudden possession of an alphabet point in the same direction.

Another question now arises: Who were the invaders? Mr. Engelhardt observes, "The Romans, we know, never conquered Denmark. Their armies, assisted by their fleets, came as far as the Elbe, but never beyond it;" but we cannot find that he endeavours to come to any conclusion on the subject, or even that he raises the question. Indeed, perhaps the only passage in the book bearing on it is a footnote, in which it is stated that Dr. L. Müller considers the religious symbol termed the fylfot "to have originated in Eastern Asia, from whence it spread over a great part of Europe." At present it would probably be futile to enter into any argument on this point, but as our knowledge of the antiquities of the same

date in other countries becomes more extended, we ought to become prepared to grapple with a problem of so much interest.

A work, entitled 'L'Homme fossile en Europe, son Industrie, ses Mœurs, ses Œuvres d'Art,' by M. Le Hon, has just been published at Brussels; and as the subject of it is coextensive with the range of this chronicle, it ought not to be passed over without notice in these pages. At the same time, as a work of this kind necessarily partakes more or less of the nature of a compilation, a detailed analysis of it would simply be a repetition, in a great measure, of what has already been stated in this and our last Chronicle. We shall therefore select for record one or two observations of the author, which contain what seem to be expressions of original views on certain subjects; and we must state our regret that they do not in all cases bear such intrinsic marks of probability as to ensure their unquestioned acceptance. M. Le Hon very properly places the first appearance of man, according to our present knowledge, after the epoch of *Elephas meridionalis*, the evidence of his contemporaneity with that animal being too doubtful for acceptance. In Europe he believes man to have first appeared after the diminution, to a greater or less extent, of the ice of the Glacial period, and after the contemporaneous upheaval of that continent. He seems to favour the idea that the human race migrated from Asia to the newly raised countries; but at the same time he believes man to have been very little more civilized than animals; and amongst other characteristics of our remote ancestors, he enumerates that of their *teeth*, indicating that they lived on fruits and roots; but how M. Le Hon became possessed of this astonishing idea surpasses our comprehension.

The author discusses the question whether the early cave-dwellers were cannibals. He accepts the evidence in support of an affirmative conclusion, but doubts its sufficiency; and, with much reason, he leaves the matter without coming to a decision. It will not be necessary for us to discuss the questions raised in the succeeding chapters, which contain very little that is new, but a great deal that must be useful to a student. We should observe, also, that in treating of the ages of polished stone, of bronze, and of iron (Early Iron age), the author seems to be much more at home than in discussing the earlier periods, of which his account is excessively meagre.

Mr. J. E. Lee has published in the 'Geological Magazine' for last December a translation of three reports by Dr. Oscar Fraas, "On the Pre-historic Settlements of the Reindeer Age in Southern Germany." It appears that the deepening of the spring-head and the watercourse of the Schussen brook, by the proprietor of some mills in Schussenreid, led to the discovery of gigantic horns of the reindeer, with smaller ones of all ages, as well as bones of the same

animal, which had been cracked to get out the marrow. Besides the remains of the reindeer, were found those of oxen, bears, wolves, the horse, and the glutton, as well as of birds and fish. "A large proportion of the horns have been formed, in a very simple and inartificial manner, into clubs or hammers, awls (some of which have projecting ears), or into agricultural tools, and other implements of incipient industry." About 600 specimens of flint flakes were discovered, besides a number of flint cores, but "no trace of metal was found, nor the mark of anything at all approaching that of a metal tool."

As regards the age of these remains, Dr. Fraas has made observations bearing both on their relative and their absolute date. Their relative age he infers to be far greater than that of any of the Lake-dwellings, and he seems to indicate his belief of their contemporaneity with the remains of the Reindeer period, discovered in the Dordogne by MM. Lartêt and Christy. As to the absolute date which can be assigned to them, we must quote Dr. Fraas's, or rather Mr. Lee's, own words:—"But a short time since there was here the pleasant little tarn, the spring-head of the brook Schussen; 700 years ago the Premonstratensian monks built their monastery; 1,000 years still earlier a Roman road, with all its traffic, is said to have passed this way; but long before all these periods there existed here a settlement where human beings carried on all the avocations of life."

Amongst the interesting monuments of antiquity, which render the valley of the Mississippi so attractive to the student of American archæology, few have obtained more attention than the group of "sacred enclosures," or "forts," whichever they may be, near Newark, Ohio. Besides these, "scattered over the same plain, and crowning the neighbouring hills, are numerous tumuli, or mounds, evidently erected by the same people that built the larger works." In a "Description of an Ancient Sepulchral Mound, near Newark, Ohio," published in the last volume of the 'American Journal of Science,' Mr. O. C. Marsh, from whose paper we have just quoted, describes the results of an excavation into one of these mounds. In it were found several skeletons and parts of skeletons, showing in some cases that the interment had been performed with great care: with them were associated piles of charred bones, the fragments of some of which were recognizable as human; showing that the interment of some individuals was accompanied by a kind of incrematory rite. With some fragmentary remains of a child was found a string of beads, neatly made of native copper, without the aid of fire, by hammering the metal in its original state. On the same string, arranged at regular intervals, were five shell-beads, of the same diameter, but about twice as long as those of copper.

At the base of the mound was found a cist, or grave, which had

been excavated in the soil before the mound itself was commenced. In it were found parts of at least eight skeletons, belonging to individuals of different ages; they had evidently been thrown in carelessly, most of them soon after death, and thus presented a striking contrast to the evidences of careful burial in the mound itself. Eleven skeletons were discovered by Mr. Marsh in such a condition as to prove that the individuals had been buried in a hurried and careless manner, and he states that "nearly all of these remains were those of women and children."

With the skeletons were found implements of flint and chert, remains of various animals, all of which are still living, and most of them still inhabiting Ohio. Two vessels of very coarse pottery were discovered; some hæmatite powder, which was probably used as paint; together with needles, spoons, a whistle, a spatula, and other objects made of bone. The manner in which the teeth were worn indicates, says Mr. Marsh, "that the mound-builders, like the ancient Egyptians, and the Danes of the Stone age, did not, in eating, use the incisive teeth for cutting, as modern nations do." We must conclude our notice of this very interesting paper by stating that the author infers the large proportion of small children represented amongst the remains to indicate "for this case a rate of infant mortality (about thirty-three per cent.) which is much higher than some have supposed ever existed among rude nations."

The 'Anthropological Review' for January contains, amongst other articles of interest, what we believe to be the most tangible account yet published of the characters and the age of the human jaw found in the Trou de la Naulette, in the Valley of the Lesse. It is contained in a summary of a paper read before the Anthropological Society of London by Mr. C. Carter Blake, who had been sent by that Society to report on the recent explorations of the Bone-caves of the Valley of the Lesse conducted by Dr. Dupont, under the auspices of the Belgian Government. As Mr. Blake's conclusions are given categorically in a very brief form, we cannot do better than record them *verbatim*, as follows:—"(1) That the deposit of stratified 'lehm' under stalagmite in the Trou de la Naulette was due to the action of slowly operating causes. (2) That the individual whose jaw was found therein was contemporary with the elephant and rhinoceros, whose remains are embedded under like conditions. (3) That some of the characters afforded by the jaw indicate a resemblance to the jaws of the Slavonic peoples of Eastern Europe, as especially exemplified in the Masures and Wends. (4) That some of the characters of the jaw from the Trou de la Naulette indicate a strong resemblance to, and exaggeration of, the characters afforded by the melanous races of men, and especially the Australian. (5) That the above characters afford a distinction between the remains found in the Trou de la Naulette

and the Trou de la Frontal, which latter contained the Reindeer-period individuals, strongly resembling the Calmucks of the present day."

We hope that the detection of these various resemblances may hereafter prove to be well founded; but at present the evidence seems remarkably slight. We also look forward to some explanation of the association in one individual of characters belonging to the Masures and the Wends, with others afforded by those races which, in the euphemistic dialect of anthropologists, are considerately termed "melanous."

The uses to which the ordinary types of Flint Implements, of the larger sort, were put by the people who made them, have been, in the minds of most antiquaries, associated more or less with war or the chase, though some have sought to prove that they were used for more peaceful and bucolic purposes, such as digging roots. The smaller implements are also generally supposed to have been used as cutting or scraping instruments of some kind; but Professor Steenstrup has recently published a paper, entitled "Imod Hr. Professor Worsaae's Tvedeling af Stenalderen; et Bidrag til Forstaaélsen af Stenalderens Kultur her i Norden," in which he compares them with certain stone objects used by the Esquimaux for the purpose of sinking their hooks, &c., in fishing. This idea is, to an Englishman, not a little novel, and hard to admit; but to a Scandinavian it may be more familiar, as the figures given by Professor Steenstrup show a considerable resemblance, in form and proportions, between the objects compared. At any rate, Professor Steenstrup's reputation is such that an expression of his deliberate opinion commands an unprejudiced consideration.

3. ASTRONOMY.

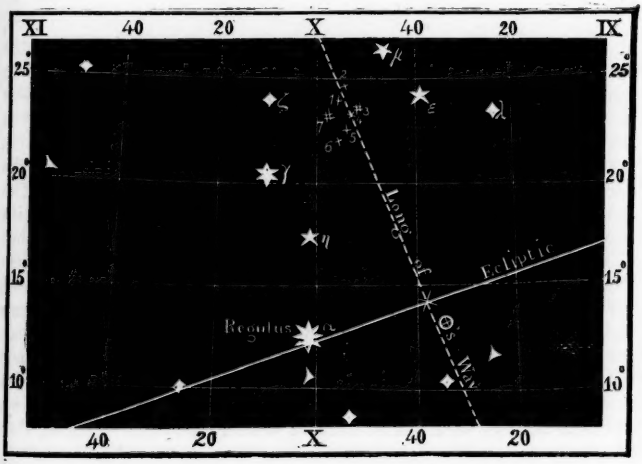
(*Including the Proceedings of the Royal Astronomical Society.*)

The gold medal of the Royal Astronomical Society has been awarded to Mr. Huggins and Dr. Miller, jointly, for their researches into the physical and chemical constitution of fixed stars, nebulæ, and comets, by means of Spectrum Analysis. Our readers, who have been presented from time to time with the results of the important investigations made by the medallists, will recognize the justice of the award.

The results of observations made by our leading astronomers upon the November meteors are now before us. In some respects they are disappointing. We cannot but feel that although the display had been predicted, it came after all somewhat as a surprise.

We miss accordingly a class of observations, which, had the shower been more confidently expected, would certainly have been suggested, — we refer to prearranged comparison-observations. If observers separated by suitable distances, had assigned themselves the task of recording the phenomena presented by the first characteristic meteor appearing after certain definite epochs, we could not have failed to have satisfactory evidence respecting the average height and velocity of the shooting stars which composed the shower. The display loses half its significance for the want of this sort of evidence. Professor Challis justly remarks on the improbability that (without some such arrangement as we have suggested) single meteors could be observed "in different localities;" he adds, with apparent regret that so favourable an opportunity was allowed to pass unused,—"it now appears to me that this class of observations is of great importance with respect to the theory of the phenomenon."

The determination of the "radiant point" of the shower was effected, however, in a most complete and satisfactory manner. It will be remembered that in Humboldt's 'Cosmos,' some doubt is expressed as to Leo being the true constellation-radiant of the November shower. The accompanying Figure will show that



doubt can no longer exist on this point. It represents "the sickle" in Leo, within which group it had been announced that the radiant point might be looked for The evidence for the determination of this point was of a twofold character:—First, in the immediate neighbour-

hood of the radiant point the paths of meteors, being foreshortened, would be reduced to mere points; secondly, the paths of all the meteors produced backwards would indicate by their common intersection near a single point the existence and position of the radiant centre. Most of our best observers obtained satisfactory evidence of both sorts; all recognized the latter phenomenon. In the figure the results of nine sets of observations have been recorded:—The small cross marked (1) indicates the radiant point determined by Mr. Alexander Herschel; (2) we have deduced from the map of the Greenwich observers; (3) marks two crosses—the upper Mr. Hind's, the lower Sir J. Herschel's determination; (4) is Mr. Pritchard's; (5) Professor Grant's; (6) Professor Adams's; (7) marks two crosses—the upper Professor Challis's determination, the lower Mr. Baxendell's. Mr. Herschel quotes ten other results, some of which we have omitted, as appearing to be the results of less exact observation; others, because there was no space for them in our figure. For instance, Mr. Penrose's determination coincides almost exactly with Professor Grant's.

Mr. Maclear, who observed the shower at the Royal Observatory, Cape of Good Hope, considers that the radiant point was nearer Regulus than μ, and about η, but he did not particularly note its position.

On one point the above evidence seems decisive. The meteors, at the time of our encountering them, were neither crossing the earth's orbit from without inwards, nor from within outwards, by an appreciable angle. In the figure, the cross on the Ecliptic indicates the point on the celestial sphere towards which the earth was travelling at the moment of encounter—or, more exactly, the point towards which we in England were being carried by the combined effects of the earth's revolution and rotation. The dotted line indicates the longitude-circle through this point (which has been called the "apex of the earth's way"). Now, the fact that the radiant point lies in the neighbourhood of this point at all, shows that we *meet* the meteor-zone; the fact that the radiant-point lies about 10° to the north (along the dotted line) shows that the zone crosses the earth's orbit from the north southwards, at an angle greater than 10°,* or, as it is technically expressed, that the meteors are at their descending node, when we encounter them. If the radiant-point had lain to the left of the dotted line, the fact would have shown that the zone crossed our orbit from within outwards—that is, that

* If we travel northwards against a rain-shower blown southwards, we are met more fully by the shower than if we are at rest; in other words, the shower seems to come from a point lower down towards the north: the amount of change depends on our velocity. Assuming the meteors' velocity not to differ greatly from the earth's (a probable assumption, as we shall see presently), the angle of 10° indicates a true inclination not differing greatly from 20°. Professor Newton's theory that the period of the meteors is 354 days, would make the angle about 19°.

the meteors were increasing their distance from the sun, while the reverse would have been shown if the radiant-point had been on the right. If we attach equal value to each of the determinations indicated in the figure, we must take as the mean position of the radiant a point not appreciably removed from the dotted line.

It follows that, either the orbit in which the meteoric zone or flight travels, is nearly circular, or (which seems less probable) that the descending node of the orbit coincides (very nearly) with its aphelion or perihelion distance. Assuming an orbit very nearly circular, we must assign to the meteors a period not differing by many days from that of our own earth. To account further for the period of thirty-three years, which separates successive recurrences of maximum intensity, we must have a period either exceeding or falling short of one year by about 1-33rd part, that is, by about eleven days. If we accept Ertel's view that the three cold days in May are due to the interposition of the meteor-zone between the earth and sun, we must suppose the mean distance of the meteors from the sun to be less than the earth's mean distance, and therefore we must take the shorter period, about 354 days. All the circumstances of the zone's motion may be determined with these data, and nothing is wanting but exact observations of the velocity with which the November meteors traverse our atmosphere, to establish Professor Newton's views on a sure basis. Professor Adams has gone through the requisite calculations for obtaining the approximate elements of the orbit; but confirmatory observations are as yet wanting.

Our readers are not to understand, however, that any doubt remains respecting the planetary motions of meteors. The mere mathematical evidence afforded by their apparent motions is sufficient to establish this point on as sure a basis as that of the Copernican theory itself. All that remains in doubt is the exact form and position of the orbit described by the meteor flight around the sun.

The observations made at the Cape Town Observatory are worthy of careful examination. Briefly, they amount to this:—The display was well seen, but not quite so rich as in England; the time at which the shower reached its maximum was about 2h. 10m. A.M., Cape Mean Time, corresponding to about 1 A.M. Greenwich time; so that the display there reached its maximum about ten minutes or a quarter of an hour earlier (as to absolute time) than in England, where 1 h. 15 m. was noted as the hour of maximum intensity; at Cape Town, as in England, the period during which the display lasted (in a marked form) was about $2\frac{1}{2}$ hours. To interpret these results we must form a conception of the earth as it was actually situated during the night of November 14th. An observer placed

in space facing the earth, as it travelled onwards at the rate of 65,000 miles an hour would have seen its northern pole well within the darkened half-disc; England would have been brought into view before Cape Town,—England more than an hour *before*, Cape Town nearly an hour *after*, local midnight. Now, if between our observer and the advancing earth, there were situate a plane of meteors inclined 19° to the ecliptic, he would have seen the lower or southern half of the disc plunging first through the plane, the upper, or northern half, appearing last. The fact, then, that some ten minutes or a quarter of an hour elapsed between the maximum displays at Cape Town and England, is fully accounted for. The earth in that time travelled forwards some 14,000 miles, but its motion relatively to a plane inclined 19° to the ecliptic would be only one-third of this, or (roughly) about enough to shift the plane from Cape Town to England. The fact that the display was somewhat less rich at Cape Town is explained by the circumstance that the earth's surface encountered the plane less directly on the southern hemisphere, where contact first took place, than on the northern hemisphere, which was bowed down towards the plane. The fact that the display lasted nearly three hours shows that the *thickness* of the meteor zone cannot be less than 60,000 miles.

The fact that no display was seen in America does not prove, as many have supposed, that the extent of the zone is small. It follows conclusively, from the results just examined, that America was on the following (or sheltered) hemisphere of the earth during the whole time that she occupied in plunging through the meteor-zone. Therefore, the invisibility of the display in America affords additional evidence respecting the *thickness* of the zone, showing that it cannot greatly exceed the above-named estimate, but supplies no evidence whatever as to the *extent* of the zone.

From the fact that England was far advanced upon the earth's *forward* hemisphere at the epoch of maximum display, it is demonstrable that every meteor which then made its appearance above the horizon of any place in England, must have reached the earth's surface, or have been dissipated in the atmosphere,—unless we assume a height of several hundred miles for the meteors. Even this assumption, which is opposed to all evidence resulting from exact observation, would only allow the escape of a few meteors, seen low down towards the north-west. The fact that, for every meteor which grazes our atmosphere, hundreds must enter it in a direct line for the earth's surface, seems to have escaped the notice of many who have theorized on the subject. It shows that for all but the largest meteors our atmosphere acts as an efficient "buffer," deadening their impulse so thoroughly that they are vaporized by the heat equivalent to their lost velocity.

The spectrum-analysis of the November meteors appears to

have been less satisfactory than that of the August meteors effected by Mr. A. Herschel. The sudden cessation of the display prevented Mr. Herschel from attending to this point as he had intended to do. Mr. Browning notes the probable appearance of a yellow line in the spectra of several meteors, and of a line of green light in the spectra of two meteors.

Herr Schmidt's observation of the disappearance of the lunar crater Linné has received the attention it deserved. It seems to be now placed beyond a doubt that a change has occurred at this point of the moon's surface. Observers have often before had occasion to suspect the occurrence of variation, but hitherto there has been no observation so satisfactory as that made by Herr Schmidt. We not only have his evidence that he has been familiar with the mountain since 1841, but the drawings of Lohrmann (1823), who described the crater as very deep. It must be explained that, for the satisfactory observation of a lunar crater, the sun must have only a small elevation at that point of the moon's surface,—in other words, we must observe the spot when near the terminator. The crater now obscured, used to become visible as a crater—that is, in shadow—when the sun's elevation was less than 5°. "*Now*," says Schmidt, "in lower altitudes of the sun, and close on the phase, not only is a crater never visible, but there appears, in a good light, and with magnifying powers of from 300 to 600 at most, a very delicate hill of 300 toises (about 1,920 English feet) in diameter, and 5 to 6 toises (about 35 feet) in height." As a light spot Linné continues always visible; as a crater it has entirely disappeared. From views taken lately by some of our most careful observers, it would seem as if the cloud, or haze, which appears to have hung over the crater, were being now gradually dissipated. Probably, in the course of a lunation or two, we shall have more definite intelligence. It will be well to avoid speculation until observation has done its work. In the meantime, we have additional evidence, if any were needed, of the value and necessity of the lunar-mapping now in progress.

We have again to refer to the variable T Coronæ, whose sudden outbreak formed one of the most noteworthy astronomical events of the year 1866. The whole significance of this occurrence depended on the question whether it were really a sudden outbreak, or whether the star arrived at its maximum of brilliancy by a gradual process of change. Mr. Hind, therefore, did well in calling the attention of astronomers to the reported observations of Mr. Barker, of Canada, who stated that he had seen the star on the 4th of May—eight days before the observation of Mr. Baxendell; and (subsequently) that he had noted a gradual increase of brilliancy up to May 12th. Herr Schmidt, on the other hand, expressed with confidence his opinion that the star was not con-

spicuous at an epoch preceding only by an hour or so the time of Mr. Baxendell's observation. We ventured in our last to express agreement with Schmidt's view,—considering it highly improbable that so experienced an observer, examining the very constellation in which the strange star appeared (in the search, too, for a variable star), would have overlooked a star brighter than Alphecca, the "brilliant" of the Crown. Mr. Stone has since carefully examined Mr. Barker's claim, and, at a late meeting of the Astronomical Society, he expressed the opinion (fully supported by the evidence adduced) that "Mr. Barker's observations, previous to those of May 14th, are not entitled to the slightest credit."

Mr. J. Norman Lockyer has commenced the spectroscopic observation of sun-spots. His object is to test the rival theories of M. Faye on the one hand, and Messrs. De la Rue, Balfour Stewart, and Löewy on the other. According to M. Faye, the interior of the sun is "a nebulous gaseous mass, of feeble radiating power at a temperature of dissociation,"—a sun-spot is caused by the heating effects of an up-rush from the interior breaking through the less intensely heated photosphere. The English physicists named above refer the appearances connected with sun-spots to the cooling effects of a down-rush from the exterior. Mr. Lockyer has not yet obtained results which he can consider quite satisfactory; but, so far as he has gone, he sees confirmation of the latter view. In the spectrum of light from the spot the absorption bands were visible, as in the spectrum given by the photosphere; they appeared even to be thicker. Further, no bright lines were visible. The observation, if confirmed by the examination of larger spots, would establish the presence of descending currents, but would leave the question of greater or less heat in the neighbourhood and interior of spots undecided. Repeated observations have been afforded of the apparent descent, with diminishing brightness, of a large portion of the photosphere into the interior of a spot, but whether the change indicates a cooling process, or rather a process corresponding to the transformation of clouds into invisible vapour, is a question which observation has not yet enabled us to answer.

It is gratifying to hear that the speculum prepared by Mr. Grubb, of Dublin, for the Melbourne Observatory, is a perfect success. The telescope will, doubtless, soon be at work. Mr. Le Sueur, of Pembroke College, Cambridge (a wrangler of 1863), is entrusted with the charge of the observatory. He has been engaged in studying sidereal astronomy under Professor Adams, at the Cambridge Observatory; and we understand that Mr. Delarue has kindly undertaken to instruct him in the principles and practice of celestial photography.

In the new edition of 'Lyell's Geology' there are presented the

results of Mr. Stone's calculation of the variations which have taken place in the figure and position of the earth's orbit during one million of years. These results are well worth careful study. They are sufficient to show how far from the truth is the statement so often repeated in works on popular astronomy, that the eccentricity of the orbit varies between definite limits with a definite period of oscillation, the position of the perihelion travelling (meanwhile) continually in one direction. On the contrary, the successive maxima of eccentricity differ considerably *inter se*, and so of the successive minima; the period of oscillation is variable; and the perihelion not only travels with variable velocity, but sometimes retrogrades for twenty or thirty thousand years together. We must pass over many maxima before we arrive at one approaching Le Verrier's estimate of the absolute maximum (·0777). In the whole range of years tabulated by Mr. Stone, the greatest eccentricity is 0·0747;—this was the case 850,000 years ago, and the earth's orbit was then nearly as eccentric as Mars's present orbit. The least eccentricity (within the period tabulated) occurred 900,000 years ago; at this time the eccentricity was 0·0102. The present eccentricity is 0·0168.

The late Dr. Hincks (shortly before his death) effected an elaborate calculation respecting an eclipse recorded in the 'Cuneiform Inscriptions of Western Asia.' The record runs:—"In the month Tisri the moon was eclipsed, and the moon emerged from the shadow while the sun was rising." Such an eclipse admits of identification. Accordingly, Dr. Hincks was able to satisfy himself that it occurred on September 13th, 701 B.C. (at the beginning of Sennacherib's reign). He adds:—"According to Hansen's Tables the moon would be very far—perhaps half a degree—beyond the place which would allow the phenomenon to appear, as recorded, in the latitude of Nineveh." But by adopting values given by Professor Adams, conjoined with a correction ascribed to a retardation of the earth's diurnal rotation, he considers that the circumstances of the eclipse can be satisfactorily accounted for.

Proceedings of the Royal Astronomical Society.

Our space will not permit us to notice separately (with whatever brevity) the papers (sixteen in number) which have reference to the November star-shower. We have already summarized the results presented in them.

Messrs. De la Rue, Stewart, and Löewy present a note exhibiting the results of their second series of "Researches on Solar Physics." Their observations indicate an apparent connection between the behaviour of sun-spots and the longitude of Venus. Jupiter's influence seems also to have been detected. The planets which

should exert the largest influence on the sun (assuming planetary attractions to be the true disturbing agent) are Jupiter, Venus, Saturn, and the Earth. Estimated according to their attractive effects merely, these planets should exert influences represented by the numbers 70, 9, 7, and 5 respectively. But as the influence exerted by Venus depends on the distance of the planet from the sun's equator, a large orbital inclination to this plane appears to be an important element of disturbing influence; so that the other three planets whose inclination to the sun's equator is about twice as great as that of Venus, should exhibit a disturbing power proportionately strengthened. Mercury, on the other hand, whose influence Mr. Dunkin considers should be nearly as great as that of Venus, travels nearly in the plane of the sun's equator; and further, the smallness of Mercury's mass is far from being "compensated by diminished distance."

The observers promise to give early attention to the influence of Jupiter, which should exhibit a period of six years, since the planet's sidereal period is about twelve years. In a later paper they exhibit the close agreement between the observations made at Kew, and those effected by M. Schwabe, at Dessau, during the year 1866.

The Astronomer Royal calls the attention of observers to the opportunity which will be afforded them in the present year of observing Jupiter without satellites. The phenomenon is very rare, having only been observed twice, one of the observations being that of Mr. W. R. Dawes. On August 21, Jupiter will be without satellites for one hour and three-quarters; and if the weather be favourable, all the four disappearances and the four reappearances may be observed in this country. They occur in the following order:—at 8h. 14m., G.M.T. (soon after sunset), the third satellite will enter on Jupiter's face; at 9h. 9m. the second satellite will be eclipsed in Jupiter's shadow; at 9h. 28m. the fourth; and at 10h. 4m. the first satellite will enter on Jupiter's face. All the four satellites will then be invisible. At 11h. 49m. the third satellite will pass from Jupiter's face; at 12h. 13m. the second satellite will reappear from behind the body of Jupiter; at 12h. 23m. the first, and at 13h. 54m. the fourth satellite will pass off the disk.

In a letter to Mr. Stone, Major Tennant, R.A., calls the attention of astronomers to the total eclipse of August 17, 1868. This will be visible in India; and the certainty (almost) that east of the Ghauts the weather will be fine, renders it the more desirable that such of our observers as may be in India at the time should take part in an observation of so much interest. "Probably," says Major Tennant, "the Council will not think that it would be too much to ask that the Government should, by organizing an observing party

or two, give the business that element of discipline and unity of action which volunteer observers, collected from various parts of a large country, will almost necessarily want."

Mr. Peacock discusses the epoch of a partial eclipse recorded on a brass plate dug up at Calcutta, and described as having occurred "in the month Chaitra, when the sun was entering the northern hemisphere, the moon being in the Nakshatra Aswini." He identifies it with the eclipse observed at Constantinople on the 3rd of April, A.D. 889.

Mr. Wray presents an interesting paper on the correction of the secondary spectrum of object-glasses. After trying "a great number of different kinds of glass," flint and crown, having densities varying from 2·833 to 5·49, he came to the conclusion that by the mere combination of glasses, the secondary spectrum could not be corrected, "with anything like a reasonably shallow system of curves, even where four lenses were used." He finds, however that by a judicious selection of flint and crown glass, separated by an extremely thin meniscus film of highly dispersive cement, it is easy, not only to destroy the irrationality, but even to invert the spectrum. Under high powers he obtains a perfectly achromatic image of the moon and planets, "which are shown in a surprisingly sharp and clean manner on the black ground of the sky, reminding one of a first-class reflector, under its very best behaviour. The Astronomer-Royal has promised to examine a large object-glass for Mr. Wray, who has constructed one for the purpose, having a 7-inch clear aperture and a focal length of $8\frac{1}{2}$ feet.

Mr. Knott exhibits in a table the apparent increase of diameter shown by star-discs as the aperture of the telescope is diminished.

Mr. Dawes remarks, with reference to the eye-piece prism suggested by him for correcting errors in double-star measurement, that in all ordinary cases he should not recommend its use; "only in those where the obliquity is such that a slight and not inconvenient inclination of the head was insufficient to bring the stars into an apparently vertical position."

The small companion of ζ Herculis having emerged from its recent conjunction with its primary, Mr. Dawes has succeeded in effecting measurement of it. One set of measures was taken *exactly at noon* on December 30th, the sky being quite unclouded. Mr. O. Struve, with the great Pulkowa refractor, found the object one of extreme difficulty, and was surprised that Mr. Dawes should have been enabled to see, much more that he should have measured the object with the smaller telescopic powers at his disposal. The measures of Mr. Dawes agree admirably with M. Struve's.

4. BOTANY, VEGETABLE MORPHOLOGY, AND PHYSIOLOGY.

England.—*The Structure of the Seed in Solanaceæ, &c.*—Mr. Tuffen West, the well-known micrographic artist, has published a paper on this subject, read to the International Botanical Congress held in London last summer. The seeds of the *Solanaceæ* are remarkable for the rugosity of their surface, being scrobiculated, or deeply pitted. Numerous observations were made by Mr. West, under a binocular of high power, and the structure was observed by making thin slices of the objects, longitudinally and transversely, by a sharp razor. The cancellated prominences seen around each depression form sinuous intersecting bars, and are caused by the extreme thickening of the walls of the cells, owing to the deposition of solid matter upon the inner surface of the original cells. In the *Scrophulariaceæ* the structure of the seeds presents a considerable difference; but in the intermediate family, the *Atropaceæ*, formed to embrace the many genera whose corolla have an imbricated æstivation, and which have been separated by Mr. Miers from the Solanaceæ so as to render this last family uniformly consistent in the valvate æstivation of the corolla, the structure of the testa, although sufficiently distinct, approaches nearer to the character observed in *Solanaceæ* than to that of *Scrophulariaceæ*. A very large series of observations on the species of various genera of these three families is given by Mr. West.

Effect of Cold on the Growth of Trees.—Professor Caspary, of Königsberg, contributed to the proceedings of the late Botanical Congress the results of some very elaborate observations on the effect of low temperatures in altering the direction of the branches of trees, from which it appeared that different species are, in this respect, acted on in diverse manners, some moving during a frost vertically upwards, and others downward; whilst a lateral movement towards the left is nearly universal.

A Heterogeneous Flora.—At the same meeting Mr. Axel Blytt, of Christiania, read a paper "On the Vegetation of the Sogne Fiord," one of the larger arms of the sea on the coast of Norway. In this singular district, cut off from the rest of Norway by impassable mountains covered with eternal snow, and lying in lat. 61° N., all seasons and climates seem to be mingled and coexistent; whilst an Alpine flora extends down to the very sea-level, and its members grow on the rocks of the shore mixed with maritime species, vines, peaches, nectarines, and walnuts ripen their fruit in

the neighbouring valleys, which are said to possess the climate of a hothouse. Mr. Blytt gives the upper limit of some of the common trees of the district, which it is interesting to compare with similar observations in this country.

The Lindley Library.—The Committee of the International Botanical Congress, in whose report the above-quoted papers and others of great value are to be found, have, after all their expenses, a residuary balance of 1,800*l.* With this they propose to purchase the Lindley Library and other books, to form the foundation of a Botanical and Horticultural Library, to be connected with the Royal Horticultural Society, provided her Majesty's Commissioners, who are interested in the advancement of the South Kensington Estate, are willing to provide a suitable reading-room, with glass cases, for the reception of such a library. The Lindley Library is largely composed of books of interest only to the student of scientific botany, and some provision should be made for making it accessible to all who would profitably use its volumes. It may very well be questioned whether a new special botanical library and reading-room is required at all—more particularly an incomplete one such as this must be, without funds to maintain it. There are other ways in which this 1,800*l.* could be made of more service to science; but then, perhaps, it would not be of so much service to the Royal Horticultural Society.

Raphides in the Lemnaceæ.—The smallest of known phanerogamous planets is not very markedly or broadly distinguished from the next species in size: that is, in other words, *Wolffia arrhiza* is in many respects similar to *Lemna minor*, and till quite recently escaped attention in this country. Dr. Henry Trimen (as we lately chronicled) has drawn attention to its occurrence, and Mr. Gulliver has now examined specimens, in order to ascertain if the microscopic structure of the tissues of the plants affords any diagnostic characters. He has ascertained that while *Wolffia arrhiza* is entirely destitute of raphides, *Lemna minor* abounds with them. This is another very encouraging proof of the value of those researches on raphidian characters at which Mr. Gulliver has so assiduously laboured.

Series of Diatomaceæ.—M. Th. Eulenstein, of Stuttgard, who is well known as one of the most active investigators of Diatomaceæ, has undertaken the publication of two distinct series of specimens of these plants. One series will consist of authentic and original specimens, and it is intended to facilitate the identification of the numerous species established by foreign authors. The uncertainty of nomenclature which has pervaded all the writings on this subject since the works of Ehrenberg and Kützing, is entirely due to a want of accurate knowledge of these specimens, which M. Eulenstein has spared no pains to obtain for the present purpose. Simul-

taneously with, but perfectly distinct from, this series, M. Eulenstein intends also to publish another series, which will form, as it were, a standard collection of the various types of Diatomaceæ, and will contain typical representatives of nearly all the known genera, recent and fossil. The number of collections belonging to the first mentioned series will necessarily be extremely limited; but it is to be hoped that the Royal Microscopical Society will be the depository of one of them. Those of the second series would appear to be almost indispensable for all real students of the Diatomaceæ, and we can only wish that M. Eulenstein may find his praiseworthy labour properly appreciated.

A New Arrangement of Plants.—Mr. Benjamin Clarke, F.L.S., has at length brought out a large folio work on which he has been for some years engaged. He calls it '*The* Natural System of Botany,' and it contains the results of a vast deal of labour and observation directed towards a new classification of Phanerogamous plants. The facts expressed in the various tables as regards the relative position of the ovule and its parts to the axis of the flower are no doubt valuable; and to aid him in working out this inquiry, Mr. Clarke received a grant of 10*l.* from the Royal Society. It does not appear, however, that the classification proposed is in any way a natural one,—indeed, it cannot be expected that the consideration of one group of organs alone should furnish data for such a classification. Many botanists are already acquainted with some of Mr. Clarke's observations from his papers published in the 'Ann. and Mag. Nat. Hist.,' in 1853, and in the Linnæan Society's transactions. The book is printed and published for the author, and, inasmuch as it is the work of many years of patient inquiry, he deserves the encouragement and support of his fellow-labourers.

New and Rare British Plants.—Dr. Moore, at a recent meeting of the Natural History Society of Dublin, showed specimens of *Eriophorum Alpinum*, L., which had been found growing in considerable abundance on the north margin of Gurthavabra Lake, in county Cork, by H. J. Ryder, Esq. Hitherto this plant has only been known in the British Isles from Forfar and Sutherlandshire. It grows in Lapland and Norway on low bogs and marshes, and occurs also in North America. Mr. Stewart, of Belfast, has also discovered the sweet flag *Acorus calamus*, L., in the Lurgan canal, in the north of Ireland. This plant is met with in the counties of Norfolk and Suffolk, but was supposed not to have crossed the Irish Channel at all.

Potamogeton decipiens, Nolte, has been discovered at Bath by Mrs. Hopkins, and is figured in the March number of the Journal of Botany. It is quite new to the British flora, having as yet been gathered only in Northern Germany, in Holstein, Slesvig, and the vicinity of Hamburg. It is not included in French floras. The

plant comes very near to *P. lucens*, but in that species the leaves are not so much rounded at each end, are slightly stalked, and the border is thickened and minutely denticulate. The stipule is winged on the back on the lower part, and the peduncle is incrassated upwards. *P. prælongus* has leaves with a similar border to those of *P. decipiens*, but they are different in shape.

Utricularia neglecta, Lehm., has lately been ascertained as a British plant from a specimen in the British Museum, collected by the late Edward Forster, in a gravel-pit in Hainhault Forest, Essex. Professor Babington has noticed this species in all the editions of his manual, as likely to be found native in Britain, and his expectations are thus realized.

France.—*Another Botanical Congress.*—We understand that the Botanical Society of France have arranged to hold an International Botanical Congress in Paris, during the time of the Exhibition, to which botanists of all countries will be invited. The Congress will open on the 26th July, and will last for a month. Meetings will be held every Friday evening at the Society's Rooms, 84, Rue Grenelle St. Germain. On other days during the period, visits will be made to the Exhibition, to the Museum of the Jardin des Plantes, to private collections, and excursions will be made in the neighbourhood of Paris, especially towards the end of August.

Vitality of Seeds.—M. Pouchet, of Rouen, the well-known advocate of the cause of spontaneous generation, has observed that a small proportion of the seeds of *Medicago Americana* are able to withstand an uninterrupted boiling for four hours without losing their vitality. In the greater proportion of the seeds thus treated the contents had swollen and broken the integument, and the water necessarily became mucilaginous, but others successfully withstood the high temperature, the outer integument resisting the water, so that when they were sown, they sprang up in the course of from ten to twenty days.

The Histology of the Dilleniaceæ.—M. Baillon contributes a careful account of the microscopic structure of various plants of this order to the 'Comptes Rendus.' His object is to show the close relation existing between the Dilleniaceæ and the Magnoliaceæ, and in particular the striking affinities with Magnoliaceæ which the Illiceæ presents. The Dilleniaceæ are enormously rich in bundles of raphides; and in the pith of *Dillenia speciosa* these crystalline needles are exceedingly abundant. The wood of Dilleniaceæ exhibits at a certain age very remarkable fibres, with areolar punctations. They do not occur in young branches, and their gradual development presents many points of interest. The dried leaves of most Dilleniaceæ are rough to the touch, and in tropical America are used for the purpose of polishing. This property is due to the accumulation in the leaves of a very large number of

concretions of a definite form, and of siliceous composition, which are insoluble in acids, excepting hydrofluoric. M. Baillon describes them minutely in *Curatella Americana*, a species which presents these siliceous accumulations on both sides of its leaves.

GERMANY.—*On the Fecundation of the Fungi.*—Professor H. Karsten has published a very valuable memoir on this subject in the 'Botanische Untersuchungen,' 1866. He had observed the fruit of a Lichen, the apothecium of *Cænogonium*, with all its spore-sacs and paraphyses, forming an hymeneal stratum, develop itself from a single cell, equivalent to a gonidial cell, and, indeed, after a previous coalescence, and apparently after the mingling of its contents with those of a branch of the cortical cells closely applied to its surface, which is furnished with porously thin spots.—The question immediately arose whether the fruit of the Discomycetes (which is in part constructed in the same way) as well as those of other allied tubular Fungi, and even those of the Hymenomycetes, were not produced in consequence of a similar process of copulation. The investigation of the development of the leafy cellular Cryptogams supports the supposition that this mode of development occurs also in the other composite fruits of the Lichens and Fungi. Professor Karsten in pursuing this question has dissected and observed the developmental history of the fruits of numerous Fungi (*Agaricus*, *Peziza*, *Helvella*), and records his observations in this paper. The following simple laws as to the multiplication of plants, results from the confirmation of his views:—

1st. The typical form of every true species of plant is propagated and maintained by sexually produced germs.

2nd. Whilst the fecundated germ-cell is developed in the Phanerogamia into a single germ, which usually rests in its envelopes for a longer or shorter period, and in the vascular Cryptogamia into one which evolves itself at once, in the cellular Cryptogamia it is developed generally into a composite fruit containing *numerous* seeds.

On Rotation and Circulation in the Cells of Plants with reference to the question of Contractility.—Professor Reichert has recently published the results of his investigations on this most interesting series of phenomena. Considered together with the invaluable observations of Professor Max Schultze on the movements of the Diatomaceæ and vegetable protoplasm, they afford a comprehensive view of the subject. Professor Reichert maintains that—

1st. In all vegetable cells with rotating, circulating, or rotato-circulating currents, two parts are to be distinguished in the contents of the cellulose capsule, namely, the central "cell-juice" or "cell-fluid," situated in the axis, and the mantle-layer, diffused between this and the cellulose capsule.

2nd. The "cell-fluid" is motionless, colourless, and non-tenacious; the "mantle-layer" consists of—first, a fluid basis, the

"mantle-fluid;" secondly, the protoplasm of Hugo Mohl; and thirdly, dispersed chlorophyl corpuscles, other corpuscles, and the cell-nucleus, which is sometimes absent. The primordial utricle, if present, bounds this "mantle-layer," separating it from the cellulose capsule.

3rd. The movements in the cell result from the action of some cause or other on the fluid part of the mantle-layer, which in its movements carries the viscid "protoplasm" and the suspended particles with it. Molecular movements of minute corpuscles suspended in the "mantle-fluid" have other causes to account for them.

4th. The movements of the mantle-fluid may be recognized either by the movement of suspended granules or of separated fragments of the viscid part of the mantle-layer, as in *Chara* and *Hydrocharis*.

5th. Various modifications of the character of the movements and their direction arise from the action of the mantle-fluid on the viscid part of the mantle-layer; and by the adhesion of the viscid substance to the cellulose wall, the diversion of the current of the "fluid," and production of the viscid matter into filaments. In all cases, however, examined by Professor Reichert, he is convinced that the proximate cause of the apparent movements is the motion of this mantle-fluid, which has been hitherto overlooked; the cause of the motion of the fluid itself he will not venture to suggest. His chief point deducible from these facts is, that the viscid material is not a *contractile* protoplasm, and is not the proximate cause of the movements. Professor Schultze discovered a moving band of "protoplasm" along the raphe of Diatoms flowing from the contents of the silicious valves, which he clearly showed caused their locomotion. Professor Reichert would regard this, according to his views above noted, merely as the viscid substance set in motion by a "mantle-fluid," and not as a self-contractile protoplasm.

Switzerland.—*The Nature of Anthers.*—J. Müller, the elaborator of the Euphorbiaceæ for De Candolle's 'Prodromus,' has published three brief papers in the 'Mémoires de la Société de Phys. et d'Hist. Nat. de Genève,' upon points relative to the anther which fell under his observation in the progress of his work. The first is a case in which the anther had reverted to a leaf, giving evidence that this organ is homologous with a plane lamina, its margins or line of dehiscence answering to the margins of a leaf. The second is upon the trilocular anther of *Pachystemon*, neatly showing that this (and, by just analogy, the three-celled anther of *Ayenia* also) is not a combination, but answers to a single leaf. The third exhibits the double flexure in the bud of the apex of the filament in *Cephalocroton*, the anther remaining upright, as contrasted with the inverted anthers of *Croton*.

5. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

THE announcement we made in our last Chronicle of the discovery of a new metal, by MM. Meinecke and Rossler, was it seems premature. The mineral they analyzed was a specimen of phosphorite which contained a trace of copper, and the blue line they saw in the spectrum was given by this metal.

An easy and cheap mode of preparing oxygen on a large scale is a great desideratum. A method has recently* been published by Mallet, which deserves attention on this account. The inventor avails himself of the fact that cuprous chloride absorbs oxygen from the air to become converted into the oxychloride, which oxygen is driven off on the application of heat. To carry out his process the author mixes the cuprous chloride with sand or kaolin, and places it with a little water in a horizontal iron retort, where it is agitated while a current of air is made to pass. After an hour or two the formation of the oxychloride is complete; then heat is applied and the oxygen collected by suitable means. The oxychloride may afterwards be revived by a repetition of the previous treatment. A kilogramme of the cuprous chloride, it is said, will give with each operation from 28 to 30 litres of oxygen. The loss of material is very slight, 100 grammes of the chloride only losing 9 grammes in the repeated revivifications necessary to furnish 36 litres of gas.

In a similar apparatus the same agent may be used to furnish chlorine. For this purpose, hydrochloric acid gas is made to traverse the retort, by which the cuprous is converted into cupric chloride. The latter, when heated to redness, gives off half its chlorine, leaving the lower chloride to be revived as before. The author suggests this process as a means of utilizing the hydrochloric acid gas from soda furnaces.

Another process for obtaining oxygen is given by Winkler. Binoxide of manganese, when heated with sulphuric acid, yields oxygen; but the sulphate of manganese produced, forms a hard cake which is apt to cause the fracture of the retort. Winkler therefore suggests the use of bisulphate of soda in the place of sulphuric acid. A mixture of three parts of the dry bisulphate and one of manganese will answer well. The bisulphate readily fuses with the heat of a spirit-lamp, and remains liquid to the end of the operation, pure oxygen being quietly evolved.

Dragendorff furnishes us with a ready means of distinguishing

* 'Comptes Rendus,' Feb. 4, 1867.

between antimoniuretted and arseniuretted hydrogen. When the former, he says, is passed over fragments of caustic potash, it is decomposed, and the potash becomes covered with a brilliant coating of antimony. Arseniuretted hydrogen is not attacked by potash and passes on unchanged.

A paper by Stahlschmidt "On the Reducing Action of Zinc,"* shows that nitrate of potash boiled with finely-divided zinc is reduced to nitrite. The following is the process adopted:—A saturated solution of nitrate of potash is gently heated with one-tenth its volume of ammonia, and some zinc in powder. At from 30° to 40° C. the action proceeds briskly, and it may be necessary to moderate it by the application of cold. In the course of half-an-hour the nitrate is so far reduced that the addition of twice its volume of alcohol to some of the solution causes no precipitate. There will be a little free potash and some oxide of zinc in the solution. The former must be neutralized with nitric acid, and the oxide of zinc removed. The nitrate can then be separated from nitrite by crystallization.

We may say here that we have recently met with an alloy of zinc, with about 12 per cent. of iron, which is easily reduced to a fine powder, and will answer the purpose of this and other experiments of the kind.

Dr. R. Wagner† proposes to reduce the cost of the production of nitric acid, by reverting to a modification of the old process for making aqua fortis. He finds that hydrated alumina, when heated with nitrate of soda, causes the evolution of nitric, and some hyponitric acid, and forms aluminate of soda. This, when treated with carbonic acid, gives carbonate of soda; and the hydrate of alumina is reproduced for future operations. This would seem to be a useful process. Silica (fine sand for example) also decomposes nitrate of soda, even at a lower temperature than the hydrated alumina. In this instance, silicate of soda, another marketable product, is obtained.

Fichter, of Berlin, recommends the use of baryta, in preference to soda or lime, in the manufacture of pure acetic acid, from crude wood vinegar. The acetate of baryta withstands the torrefaction, necessary to get rid of the empyreumatic matters, much better than the acetates of lime or soda, and there is consequently a much smaller loss of acid.

One other technological matter deserves notice. Bolley has found that hypochlorite of magnesia bleaches much faster than the corresponding lime compound. Magnesia, he shows, is much the weaker base, and more readily parts with its chlorine. In the case of straw, he states, the hypochlorite of magnesia has a special advantage.

* Poggendorff's 'Annalen,' 128, 466.
† Dingler's 'Polytech. Journ.,' 1 Jan. heft.

We gave in our last, a process by Dr. Wagner, for estimating the gallotannic acid in tanning materials. Another process has since been published by R. Pibram,* who exhausts the material to be examined with boiling water, filters the liquor, and precipitates with a solution of one gramme of sugar of lead in fifty grammes of water. The precipitate is collected on a weighed filter, carefully dried at 120° C., and then weighed. It may now be ignited in a porcelain crucible, and the tannin estimated by difference. This method is simple, and will probably give sufficiently accurate results for trade purposes.

We may mention here, a critical examination of some of the published processes for the estimation of Tannin, by Mr. John Watts,† who gives the preference to the process of Mittenzwey. This is an application of the well-known fact, that an alkaline solution of tannin will rapidly absorb oxygen. We must refer the reader to the original paper for a full description of the process; but as some may be employing it, we must mention a correction made by Mr. Watts. Mittenzwey states that a gramme of tannin absorbs 175 ccs. of oxygen at 20° C. Mr. Watts, however, has ascertained, by repeated experiments, that the volume of oxygen actually absorbed is 231 ccs.

The length to which our notice of the Chemical Society extends, obliges us to omit any other matters, which would otherwise have found a place.

Proceedings of the Chemical Society.

At the meeting held on December 6, Mr. E. T. Chapman read a paper "On the Synthesis of Formic Acid." Struck by the fact that by oxidation acetate of ethyl yields two equivalents of acetic acid, Mr. Chapman came to the conclusion that nascent oxygen could not be the sole agent in effecting the change. In the case mentioned there is the same amount of hydrogen in the products obtained as in the substances operated upon. From this it would appear that either the ethyl had given up a portion of its hydrogen to the residue of the acetic acid, and then appropriated to itself two equivalents of oxygen, or that the acetic ether had been decomposed by the assimilation of water and the substitution of oxygen for hydrogen, which amounts, in fact, to the action of hydroxyl and the direct addition of hydrogen. The author believes that in most cases of oxidation of organic bodies this substitution of hydroxyl for hydrogen, or its super-addition, takes place. The synthesis of formic acid seems a direct proof of this. When finely-divided carbon (lamp-black) is boiled with permanganate of potash and sufficient sulphuric acid to liberate the permanganic acid, formic

* Wittstein's 'Vierteljahrsch,' 15, 520.

† 'Pharmaceutical Journal,' March, 1867.

acid is produced, in very small quantity it is true, but sufficient for the author to identify and determine. Mr. Chapman took especial pains to purify the lamp-black used in the experiment, so as to preclude the possibility of any hydrogen compound being present.

After this Mr. Parkinson gave an account of "Some Alloys of Magnesium, and its behaviour with non-metallic elements." The details given by the author were very long, and for a full account we must refer the reader to the 'Journal of the Chemical Society' for March, 1867. It is sufficient to say that none of the alloys of magnesium promise to be of any utility. Some of them, however, are possessed of curious properties. Bismuth, for example, with 10 per cent. of magnesium, forms an alloy which deliquesces when exposed to the air. The action of air and moisture is so great that it hisses distinctly when held in the hand. Antimony, with 10 per cent. of magnesium, behaves similarly. All the alloys are very brittle, and are easily tarnished. The one which seems the most permanent is that with zinc. The two metals must be fused together in an atmosphere of hydrogen, for when heated together in the air or under a flux the reaction is violent and explosive. The most interesting of the compounds formed with non-metallic elements is that with silicium. When silica is heated to redness with magnesium filings, silicide of magnesium is produced, which decomposes water and causes the evolution of spontaneously inflammable silicide of hydrogen.

On the same evening Mr. R. H. Smith read a paper "On the Oxidation of Ethylic Benzoate."

At the meeting on December 20, Mr. W. H. Perkin read an important paper "On the Bibasicity of Tartaric Acid." Tartaric acid has, until lately, been regarded as bibasic; but its tetratomicity being established, some chemists have found reasons for considering it tetrabasic. These conclusions have been drawn from the composition of some metallic combinations; but Mr. Perkin has studied the replaceable hydrogen in a different manner, and from the examination of new derivatives of the acid, establishes its bibasicity. We must refer the reader interested in this question to the original paper, which will be found in the 'Journal of the Chemical Society,' for March, 1867.

At the same meeting, a paper by Dr. Hunter, "On the Absorption of Vapours by Charcoal," was read. As in the author's previous experiments, cocoa-nut charcoal was employed. The vapours experimented upon were such as those of aniline, carbolic acid, aldehyde, &c., and the determinations have no immediate practical value.

Mr. Herbert M'Cleod afterwards exhibited a new continuous aspirator of his contrivance. This form of apparatus could not be made intelligible without an engraving. Its only advantage

appears to be that it enables the chemist to determine with ease the amount of air aspirated.

The two foregoing papers will also be found in the March number of the Journal of the Society.

Another paper, on the same evening, was by Mr. E. T. Chapman, "On some Reactions of Hydriodic Acid." This acid, the author found, converts nitric oxide into ammonia, and decomposes nitrites, and with more difficulty nitrates of the alcohol radicals into nitric oxide, ammonia, and water, an iodide of the alcohol radical being also formed.

On January 17, a paper by Mr. T. E. Thorpe, "On the Amount of Carbonic Acid in Sea-air," was read. The author's experiments were made off Douglas, Isle of Man, and the average result of 77 observations was 3 parts of carbonic acid in 10,000 of air.

Another paper, by the same author, was "On the Amount of Carbonic Acid contained in the Atmosphere of Tropical Brazil, during the Rainy Season." At Para, during April and May, 3·28 parts of carbonic acid were found in 10,000 of air. Four parts in 10,000 was said to be the mean result for the atmosphere of Europe, away from special contaminating influences.

Dr. Frankland then read a learned paper, giving the latest results of the "Synthetical Researches on Ethers," carried on by himself in conjunction with Mr. Duppa. This second part gave an account of the action of sodium and isopropylic iodide upon ethylic acetate.

Professor Wanklyn afterwards read a paper "On the Titration of Compound Ethers." An elementary analysis, the author found to be a poor guarantee of the purity of a compound. He therefore resorted to a titration, which he finds rapid, easy, and accurate. He digests known amounts of the ether and alcoholic potash in a water-bath, and when the decomposition is terminated, which is known by the complete disappearance of the smell of the ether, the residual potash is determined by means of a standard sulphuric acid.

A paper by Mr. E. T. Chapman and Mr. M. H. Smith, "On Quantitative Anaylsis by limited Oxidation," was also read. The authors have oxidized lactic and diethoxalic acids by means of chromic acid, and determined the amounts of the resulting products. Such a mode of analysis they believe to be applicable to most organic compounds, and would show not merely the total amount of carbon, but also the forms in which it existed in the compound examined.

The last paper of the evening was by Dr. Stenhouse, "On the Preparation of Berberine from Coscinium Fenestratum, commercially known as Colombo-wood." The author exhausts the wood with a

boiling solution of subacetate of lead. Part of the berberine separates on cooling, and the rest is precipitated on the addition of nitric acid. The nitrate may be decomposed by lime or ammonia, and the alkaloid purified. The same process is applicable for the extraction of theine from tea.

At the meeting on the 7th of February a note by Dr. Stenhouse, "On some Varieties of Orchella Weed, and Products obtained therefrom," was read. The author described the mode of obtaining orcin and erythrite from Rocella tinctoria; for details of which, and also of a mode of determining the amount of colour-yielding principles of lichens by the use of a standard solution of hypochlorite of sodium, we must wait the publication of the paper.

A note by Dr. Phipson, "On the Eggs of Corixa Mercenaria," was also read. These eggs deposited on reeds in fresh-water lakes in Mexico, by a kind of boat-fly, are ground by the natives and used as food. They are chemically composed of chitine with a little phosphate and carbonate of lime. Chitine, Dr. Phipson believes to be a glucoside. The eggs are supposed to contribute to the formation of a new oolitic limestone at the bottom of the Mexican lakes.

After this, Dr. Matthiesen gave an interesting lecture "On Alloys." We need only say here that the author disputes the notion that alloys are definite chemical compounds (except indeed in one or two instances), and only regards them as intimate mixtures of the metals. In some cases, however, in which the physical properties of one metal are entirely changed by a small admixture of another, the resulting alloys, it was said, could only be regarded as solidified solutions of allotropic modifications of the metals in each other. This view of the author was more fully developed in his Report to the British Association, 1863.

The last meeting we can notice was held on March 1, on which occasion Mr. E. T. Chapman read a paper "On Limited Oxidation: the Determination of the Oxygen Consumed." Referring the reader to the paper before noticed, we may say that a known quantity of the chromic acid solution is titrated with oxalic acid, and the resulting carbonic acid weighed. Another quantity of the chromic solution is then digested with the organic body, as previously described, and after digestion the solution is titrated in the same manner with oxalic acid. The difference in the amount of carbonic acid obtained, is the measure of the oxygen consumed. This method was specially recommended for the estimation of alcohol, and generally as a proved method in a great variety of quantitative examinations.

6. ENGINEERING—CIVIL AND MECHANICAL.

The winter season is not generally the busiest time amongst members of the engineering profession; works already commenced are, of course, not permitted to remain at a standstill, but few new works are commenced until the spring. Mechanical engineers generally are now beginning to get more busy, after rather a long period of stagnation; locomotive engineers especially have plenty of work before them, and others are perhaps more or less occupied in connection with the forthcoming Paris Exhibition.

The bills before Parliament do not exhibit any very great activity on the part of engineers, there being only ninety-six for railways, whereof sixty-one are for new lines, few of which are of any great length; and eighty-three for miscellaneous works.

Amongst the many important railway works at present in progress, may be mentioned the Great Eastern Metropolitan Extension, and the East London Railways, between Mile End Old Town and Liverpool Street. Between these points, the two lines will follow the same course, only at different levels; the East London being below the surface of the ground, and the Great Eastern above it, thus necessitating the construction of a combined viaduct and covered way. The former line will also make use of the Thames Tunnel, and will serve a very important purpose in connecting the lines north and south of the Thames to the East of London Bridge. Four-fifths of the length of the Metropolitan and St. John's Wood line has now been completed, and it is expected that it will be opened early in the autumn of the present year. One of the bills before Parliament is for the reintroduction of omnibus railways into London; there can be no doubt that such an addition to the present means of communication would be most acceptable, but whether it will prove more successful than the similar attempt made a few years back by Mr. Train, remains to be proved. In Liverpool also, an effort, supported by the Town Council, is being made in the same direction.

The works on the Great Northern Railway, between Doncaster and Gainsborough, were expected to have been completed by the 1st March; on the opening of this line the whole of the coal traffic between Doncaster and London will pass over it *viâ* Lincoln and Peterborough. The Stonehouse and Nailsworth branch of the Midland Railway was opened in February last. The opening of the Salisbury and Dorset Railway took place on the 27th December; and the extension to connect the Neath and Brecon line with the Brecon

and Merthyr system has been completed; thus opening a new route from Swansea, Llanelly, and the western districts of South Wales to North Wales, Birkenhead, Liverpool, Manchester, &c.

With reference to Railways abroad, we notice that the line over Mont Cenis is rapidly approaching completion; and it is expected that the section between Modane and Susa will be opened by May next, and that the whole will be completed by the following July. Several lines of railway in and about Paris have recently been completed, and others are in contemplation in connection with the Chemin de Fer du Ceinture. In Prussia, the construction of railways from Harburg, opposite Hamburg, to Stade and Cuxhaven, and from Nordhausen, in Central Germany, to Erfurt, have been commenced. In Russia, much has already been done, and out of 3,235 miles sanctioned, 2,570 are open to the public. There is the Trunk line of 400 miles, from St. Petersburg to Moscow; the St. Petersburg and Warsaw line of about 800 miles, with a branch to the Prussian frontier; several short branch lines from St. Petersburg, and the line from Warsaw to the Austrian frontier, about 446 miles. Southwards, there is a line from Odessa to Balta, with a branch to Tiraspol to the west. About ninety miles of line are being made in the valleys of the Volga and the Don. Lines will radiate from Moscow to Nijni Novgorod, to Serguicosk, to Riasan and Koslof. About 630 miles are being made from Orel, *viâ* Smolensk and Uitepsk, to Dunaburg, which will give those towns direct communication with the Baltic at Riga. The further extensions contemplated will complete the through communication between the Baltic provinces and the south, including the parts of the Black Sea, the Sea of Asof, and the Caspian Sea. The lines recently opened in Italy, consist of that connecting Pavia, Cremona, and Brescia; and the line between Catania and Messina. Passengers can now go from Florence to Rome in twelve hours by way of Perugia, the line between Arezzo and Foligno being now completed. The month of January last witnessed the opening of a railway section from Pasewolk to the frontier of Mecklenburg; the completion of this link is of the greatest importance to Stettin, as the Pomeranian network of lines will now be united to a vast district, comprising the whole territory of Mecklenburg, Schleswig, Lauenburg, the Hanse Towns, and a great part of Hanover. The Estramadura Railway, also recently opened, establishes an uninterrupted communication between Lisbon and St. Petersburg, by means of a line of rails 3,940 miles in length, which, starting from the north of the Tagus, terminates for the present at the confluence of the Volga and the Oka, at Nijni Novgorod, passing through Madrid, Paris, Brussels, Berlin, and Warsaw. In India, several short but important sections of railway have recently been completed. The first train ran into Delhi on the morning of the

24th October last. A sufficient number of detached portions of railway are now open to admit of the journey from Calcutta to Bombay being performed in about four days. Forty years ago the United States had but three miles of railroad in operation; but they now have 35,341 miles open, and 15,943 miles under construction. The United States Congress, in order to aid the establishment of the South Pacific Railroad, has granted that undertaking 25,000 acres of land per mile; the distance between New York and San Francisco by this route will be 3,200 miles. Advices from Brazil state that the San Paulo Railway was expected to be opened on the 1st January last; and that a prospectus has been issued of the Paraguassu Steam Tramroad Company, for the construction of a train line of 250 miles, from the city of Bahia to the city of Lençoes, near the diamond-mines, with which there is already a steady traffic.

Amongst harbour and dock works we may notice, in the first place, the extensive additions now in progress to the Government docks at Chatham, on a tract of marsh land known by the name of St. Mary's Island. For some time past the admiralty have been carrying on some very important works, with a view of reclaiming St. Mary's Island; but in addition to the mere work of reclamation, the scheme includes the construction of a series of extensive docks and workshops, all of which are estimated to cost about one-and-a-half million sterling. The Millwall Docks, now in course of construction on the Isle of Dogs, will, it is expected, be finished and open for shipping by the end of next autumn. There will be two docks,—the one of 25 acres, and the other 10½ acres in extent; the depth of water in each basin will be about 29 feet and the entrance locks will be 80 feet wide. A large graving-dock, 402 feet long by 86 feet wide, is also being constructed as an adjunct to the other works. On the 1st January the contractors commenced the great works for the extension of Portsmouth Dockyard, the estimated cost of which is 1,500,000*l*. Up to the present time Glasgow has been without any dock accommodation, or tidal basin; and although the wharfing is extended on either side of the river for a great distance, it is inadequate to the demands upon it. A tidal basin is now in course of construction there, which will be completed in a few months; and the commencement of another basin is contemplated soon after the completion of that now in progress. New works are under construction on either side of the river at Belfast; those on the County Down side consist of a large open tidal basin and a capacious graving dock; and those on the County Antrim side consist of a floating dock, 630 feet long by 225 feet wide, and a tidal dock 600 feet long by 550 wide. The entrance to the former is 60 feet, and to the tidal dock 80 feet in width. The cost of the entire works will be 150,000*l*. A new port has not long since been established in the Bristol Channel, at

Port Cawl, in Glamorganshire, which will be of immense value to the ironmasters and coal lessees of South Wales. The new works recently constructed here consist of an inner floating dock of 7½ acres, with quay walls of massive masonry. The depth of water in the entrance basin and on the sill of the dock is 29 feet, at spring tides. In addition to the docks there is also an extensive wharf frontage, high level shipping stages, and other conveniences. Active operations are in progress for constructing docks and a pier at the Cape of Good Hope; the principal basin has to be mined in rock, and the *débris* has been carried away by locomotives to the extremity of a breakwater, which has now a length of nearly 1,700 feet. The Pasha of Egypt has ordered, in France, a great iron floating-dock for service in the Port of Alexandria. Harbour works are also in contemplation at St. Helier's, Jersey. It is proposed to construct docks and warehouses, and to form a spacious harbour on the Danube, and to establish a port to the north of Elsinore, in Denmark.

Several proposals have recently been put forward, for the purpose of facilitating the means of communication across the British Channel. Amongst others, Mr. James Chalmers has introduced a modification of his well-known scheme for a railway beneath the Channel, to be conducted through a double row of iron pipes, lined with brick, and submerged. Other more probable schemes have been suggested by Mr. Fowler and Mr. Daft, for the establishment of ferry-boats which shall convey a railway train entire—passengers and all—without necessitating any change of carriages.

From the report of the Manchester Boiler Association it appears that boiler explosions are steadily increasing in number and fatality. During the year 1866 there were 73 explosions in various parts of the United Kingdom, attended with a loss of 87 lives, and with injuries to 110 others. Amongst other recent inventions for the removal of boiler scale, the most remarkable is that known as the magnetic anti-incrustator. It consists of seven small magnets made of steel wire, tapering to a point at one end, and inserted radially at the other into a brass centre; this is supported horizontally in the steam space, a few inches below the roof of the boiler near one end, by a brass stud, from which it is insulated. A copper wire connects the system of magnets with the opposite end of the boiler; a current of induced electricity is thus effected, which results in the complete detachment of scale from the boiler. A new kind of boiler, called the water-tube boiler, has lately been invented both in this country and in France; its peculiarity consists in the water being contained in tubes, amongst which the flames from the fire circulate, being very nearly the opposite to the plan formerly more generally adopted. Experiments are still being carried out, with a view to the use of petroleum as fuel; but more must yet be accomplished before it can be said to have proved successful.

It is proposed to convert all the existing 32-pounder guns in the service into 64-pounders, upon Major Palliser's principle. It is reported that the converted Sneider rifles have not given satisfaction, owing to the imperfect style of workmanship in their conversion. There have recently been extensive trials of breech-loading guns, both in Vienna and in America, with a view to obtaining the best pattern gun; and similar trials will shortly take place in this country. An English gunmaker has just contracted with the French government for the manufacture of a considerable number of the Chassepot gun, and the Whitworth Company are making upwards of 200 lathes for a private firm in Paris, who have contracted to convert a large number of French rifles upon the same system.

The Mont Cenis tunnel has, during the past year, been extended 1,139 yards, making the aggregate distance pierced 7,083 yards; the total distance remaining to be pierced is 6,493 yards.

The fresh-water canal portion of the Suez Canal is now navigable; on 11th February a vessel from Siam, containing packages for the Paris Exhibition, took that route; and on 17th February a vessel of 80 tons, from Trieste, arrived in the Red Sea, having passed through Egypt by the Suez Canal.

The first locomotive made in New South Wales was tested on 15th November last on the branch line between the Redfern Railway Station and Pyrmont. It is upwards of 70-horse power, and is to be employed on the steep inclines or zigzags on the Great Western Railway.

Very considerable works for the reclamation of land in Switzerland have been determined on in the neighbourhood of the Lakes of Morat, Neuchâtel, and Bienne. The total cost will be about 300,000*l.*, and the value of the lands will be increased 626,382*l.*; the total extent to be reclaimed amounts to nearly 50,000 acres.

Mr. James Parker, a gentleman residing near London, has lately introduced a system of working engines by mixed steam and air, which he applied to the propulsion of a small road locomotive some time ago, and more recently for propelling a small vessel on the Thames. The results of these experiments were very satisfactory, and the subject has recently attracted no little attention.

Amongst the numerous treatises which come before the public every year, none perhaps aim at higher ends, or achieve more general good than those which treat science in a popular manner, without making scientific truths too subservient to the popular tastes. In the category of such works may be included the three series of "Useful Information for Engineers," which have lately emanated from the pen of Mr. William Fairbairn. The third series of this very useful little work has but recently seen the light; it consists of a reprint of six lectures, some of which have been published and

distributed in the transactions of various societies and institutions, and seven papers on various subjects compiled by Mr. Fairbairn himself. The first two lectures contain a short and concise history of the advancements made in science and art; the results arising from which have been to quadruple the productive powers of the country, and to diffuse a spirit of intelligence amongst all classes of the community. The third chapter is on "Labour: its Influences and Achievements." After pointing out the necessity of labour, on which all are dependent for their subsistence, the author divides his subject into two heads—viz., *mental* and *physical* labour, which is further subdivided into *skilled* and *unskilled* labour. The points sought to be established in this lecture are, first, that labour is inherent in man and in animals; secondly, that its use is important, and ought to be cultivated; thirdly, that its influence is powerful and effective; and lastly, that its achievements are great. The fourth lecture on "Literary and Scientific Societies" is a reprint of an address delivered at the inauguration of the Southport Athenæum. In this the advantages of literary and scientific institutions are pointed out, as well as the necessity of careful study and untiring industry, for the attainment of distinction and success. The two other lectures are on "The Thickness of the Earth's Crust," and on "Iron and its Appliances." In the latter of these, iron is followed through the different stages of its utility, and it is treated in its appliance to the steam-engine, to millwork, and to machinery; the varied forms and conditions being noticed in which it is employed for security, on the one hand, and its economical distribution for the purposes of construction, on the other.

The other papers relate to the machinery of the Paris Exhibition of 1855, and of the London Exhibition of 1862, to which are added a treatise on Iron Roofs, Researches on the Insulation of Submarine Cables (undertaken at the request of the Atlantic Telegraph Company), and Experiments to determine the effect of impact, vibratory action, and long-continued changes of loads on wrought-iron girders.

At the present time, when every one is expected to possess some knowledge on scientific subjects, papers such as those above referred to cannot become too generally known; for whilst they contain much "useful information for engineers," the absence of all unnecessary technicalities renders them suitable also for the general reader.

7. ENTOMOLOGY.

(Including the Proceedings of the Entomological Society.)

From investigations made by M. Felix Plateau* on the muscular force of insects, he deduces the following law:—"In the same group of insects, the force varies inversely to the weight, that is to say, that of two insects belonging to the same group, the smaller presents the greatest strength." The Phytophagous families, Donaciidæ and Crioceridæ, appear to exceed all others in traction-force. The supremacy of these insects he attributes solely to their great muscular force, which is explained partly by the large size of the posterior femora, and partly by their small weight. With regard to the leaping powers of the Orthoptera, he found that *Œdipoda grossa*, which weighs 0·646 gr., raised a mean weight of 1·064 gr., and *Œdipoda parallela*, 0·194 gr., raised a mean weight of 0·638 gr. The proportions of their relative force are, therefore, 1·647, and 3·288; another example of the above law, according to which, in the same group of insects, the lightest are comparatively the strongest. As regards flight, M. Plateau finds, also, that the mean forces of insects are still in inverse proportion to the weights; but he obtained no such high results as in the case of traction or pushing.

Allusion has already been made (*ante*, p. 111) to the discovery, by Sir John Lubbock, of a new type of centipede. An elaborate paper on the subject has since been read before the Linnean Society. The animal is only $\frac{1}{25}$th of an inch in length; has a body composed of ten segments, with only nine pairs of legs, and five-jointed antennæ bifid at the extremity and quite unlike those of other Myriapods. It was proposed to be called *Pauropus Huxleyi*. The author, who has found it in great numbers in his kitchen-garden at High Elms, was at first disposed, from its minute size, to regard it as a larva; but, having examined several hundred specimens, he had come to the conclusion that it was a mature form. In its earliest state it has three pairs of legs, and the number increases at each moult; two pairs at the first, but at each of the subsequent moults a single pair only is added. Its systematic position among the Myriapoda is a matter of doubt. Sir John went very minutely into the reasons which induced him to consider that it could not be placed in either of the two great orders of the class, and that it is not only intermediate between the Chilopods and Diplopods, but that it forms a connecting link between the Myriapoda and the other classes of the annulosa. From the view of its being the type of

* 'Ann. and Mag. Nat. Hist.,' Feb., 1867.

a distinct order, however, Professor Huxley expressed his dissent. A second species of the genus was found with the first, differing in the form of the antennæ.

M. de Marseul has recently published a new edition of his 'Catalogus Coleopterorum Europæ et confinium.' The number of species is now above 16,000; but it must be recollected that to the European area is added the shores around the Mediterranean, or, in other words, North Africa and Western Asia. By this arrangement, however, comparatively few extra European genera are introduced, almost the only ones from the tropics being *Monomma*, *Callirhipis*, *Stenochia*, *Piazomias*, *Myllocerus*, and *Arrhenodes*. *Articerus* and *Himatismus*, Australian and South African genera respectively, are also represented. The work has been got up in a very careless manner; wrong authorities are often given, and the spelling is by far too frequently faulty.

The little work by Miss Stavely, on 'British Spiders, an Introduction to the Study of the British Araneidæ,' it is admitted "lays no claim to originality; the work of Mr. Blackwall on the same subject having been most freely used." It is one of the series of books on British Natural History now in course of publication by Lovell Reeve and Co., by whom we are informed they were to be "entirely the result of original research, carried to its most advanced point." This is a little too bad. As a useful abridgement of Mr. Blackwall's 'History,' Miss Stavely's volume may be recommended; but we think it would have been improved if she had given some notices of the habitats. Many species have only been taken once, or in one locality, and this it is very important should be known to the collector, for whom the work is more especially adapted.

The last part of the 'Linnæa Entomologica,' containing upwards of 480 pages, is entirely confined to, and completes Dr. Suffrian's descriptions of, the South American Cryptocephali. The plan of devoting as large a space as possible to a paper, instead of breaking it up into fragments, as is now too often the case, is much to be commended. In the enormously increasing mass of zoological literature, could not some plan be devised by which any paper may be taken out of the volume in which it appears, in order that it may be kept or classified with others of the same character? Many small, but important, papers are now often overlooked or forgotten.

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF LONDON.

December 3.—A collection of Coleoptera from Rio Janeiro was exhibited by Mr. Janson. *Stenus major*, Muls., an insect lately found at Southend and new to Britain, was exhibited by Dr. Sharp. In

reference to the explanation of the cause of mimicry in butterflies, an instance was given by Mr. Bolt, of Maranham, who, having an opportunity of watching the nest of an insectivorous bird, found that the Heliconidæ, the family imitated, were invariably rejected. In reply to an observation of Dr. Sharp's, that the fact of a bird not catching an imitating butterfly like *Leptalis*, implied a want of perception on its part, Mr. Wallace said that birds sought their prey by sight and not by smell, and that it was not to be expected that a bird would catch a thousand distasteful *Heliconias* on the chance of obtaining one *Leptalis*, such being the proportion of numbers of the two insects. A paper was read by Mr. M'Lachlan on a new genus of Hemerobiidæ (*Rapisma*), and another of Perlidæ (*Stenoperla*).

December 7.—Captain Hutton, in a communication respecting the Japan silkworm (*Bombyx Yamamai*), expressed an opinion that it was nothing more than a hybrid between *Bombyx mori* and *Bombyx Sinensis*. Prof. Westwood, in exhibiting a selection of the butterflies collected many years ago in Brazil by the late Dr. Burchell, observed that an examination of this collection, which was made over a long line of country, the locality of each specimem being carefully recorded, had almost induced him to abandon his belief in the immutability of species; but he reserved the subject for fuller details at a future meeting. The following papers were read:—By Professor Zeller, communicated by Mr. Stainton, "On the *Crambidæ* and other Families of Moths," collected by the Rev. O. P. Cambridge in Egypt and the Holy Land; by Mr. Butler, "On the genus *Hestia*, with remarks on the natural affinities of the *Danaidæ*."

January 21.—*Annual Meeting.*—The President delivered an address, after which the following officers were elected for 1867:—*President*, Sir John Lubbock, Bart., F.R.S., &c.; *Treasurer*, S. Stevens, F.L.S.; *Secretaries*, J. W. Dunning, M.A., &c., and D. Sharp, M.B.; *Librarian*, E. W. Janson. It was announced that one of the prizes offered by the council for essays on Economic Entomology had been awarded to Dr. Wallace, of Colchester, for an essay on the oak-feeding silkworm of Japan.

February 4.—Mr. Wormald exhibited a collection of insects from Shanghai, made by Mr. W. Pryer, among which was a new *Bombyx*, allied to *B. Huttoni*. Mr. Janson exhibited a collection of insects from Vancouver's Island, including a specimen of the curious genus *Plectrura*. Mr. C. A. Wilson, of Adelaide, communicated some notes on *Cerapterus Macleayi* and *Calosoma Curtisii*—the latter was now found under the dried droppings of cattle, a habitat it has chosen since the introduction of those animals. Dr. Wallace read a paper "On some Variations observed in *Bombyx Cynthia* in 1866."

February 18.—Mr. Moore gave an account of the ravages of *Tomicus monographus* in India. This destructive little beetle has caused the loss of vast quantities of ale, in some cases amounting to 50 per cent. of the stock in store, by eating its way in all directions in the wood of the casks, until at some point, at last becoming perfectly porous, the contained liquid escapes. The insect has not been found in this country, although common on the continent; but it is stated that the oak staves of which the barrels are made are imported from Sweden. The inference is, therefore, that the eggs were in the wood at the time they were being made into casks; how they escape destruction during the preliminary process of steaming seems unaccountable. The insects were known in Burmah previous to 1862, but are now found in most parts of India. No case seems to have occurred in which the ale escaped while *in transitu*. Mr. Newman exhibited an ant taken at Kinloch Rannoch, and new to Britain. It was doubtful whether it was to be referred to *Formica herculeana* or *F. pubescens*; it was stated to form single cells in the stumps of old pines. Mr. Wallace read a paper "On the Geographical Distribution and Affinities of the Eastern Pieridæ." The subject, in all its aspects, was treated in the most comprehensive manner, but the views of the author, in reference to the extent of the Indian Islands as a Zoological Region, were combated at some length by Mr. Pascoe. A paper "On the Distribution of the Lepidoptera in Great Britain and Ireland" was communicated by Mr. Herbert Jenner Fust. This was a long and most elaborate essay, in which the distribution of 945 species were classified according to their geographic types and the areas to which they were limited in the United Kingdom; the *Tineinæ* and one or two other groups were excluded. A paper "On the *Buprestidæ* of the island of Penang was communicated by Mr. E. W. Saunders.

8. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

The place of Admiral Fitzroy, as Corresponding Member of the Paris Academy of Science, is to be filled by Captain Richards. Mr. R. H. Major, Hon. Sec. of the Royal Geographical Society, has been appointed Keeper of the Map Department in the British Museum; a new post, for which Mr. Major has well qualified himself by his researches in Ancient Geography.

This subject of Ancient Geography has received much attention of late on the other side of the Channel. A new translation of the amended text of Strabo is being produced by MM. Amédée

Tardieu, Sub-librarian, and Thoulin, the Librarian of the Institute, who have published one volume of the work. The Geography of Ptolemæus is also being reproduced in photo-lithography, from a MS. belonging to the Vatogedi Convent on Mount Athos, which has some remarkable old maps.

In England the Palestine Exploration Fund represents what we are doing for Ancient Geography. It is intended to form a museum of objects collected. Unfortunately South Kensington has been chosen as the site, otherwise the design is a most excellent one. The objects are to be classed into Sacred, Domestic, and Political Antiquities, with Geography and Natural History, and they are to consist of sculpture, casts, models, coins, photographs, pictures, plans, maps, and collections of animal, vegetable, and mineral products. In the meantime excavations are to be carried on this year to determine the site of the Temple and Holy Sepulchre. The proceedings of the Exploration Fund lead to discussion of many points, and the production of information from many others besides those immediately employed.

The exactitude of longitudes is a matter of great importance. M. Mouchez has drawn the attention to the fact that there is a difference of 30 seconds between the longitudes of Rio Janeiro as given by different authorities. The distance of Valentia from Heart's Content in Newfoundland has been determined lately at 2h. 51m. 56·5sec. For this we are of course indebted to the telegraph. A proposition has been started in New York to extend the line which is to run across Behring Straits down the coast below the Amoor to the Chinese cities, thus to connect New York with Pekin. The Australian Governments have commenced a line northwards to the Gulf of Carpentaria, and are willing to contribute a share towards the communication with the East Indian lines, but the Indian Government are not inclined to risk anything on submarine lines without assistance from home, owing to their experience of the Red Sea route.

The Leichhardt expedition has met with many repulses—it lost its leader, it has suffered great privations; but it is said that the skull of a European supposed to be that of the great traveller has been found. A later mail gives an account of the murder of Europeans by natives many years since, so that little doubt remains of the fate of the explorer. The question of the boundaries of the various colonies of Australia is again cropping up. A portion of the district on the Murray is 180 miles from Melbourne, across level country, but is 420 miles from its capital, Sydney, across the Blue Mountains and other ranges; the consequence is that judges and other officials visit this district by way of Melbourne.

Considerable attention has been turned, by a discussion to which we alluded in a previous number, to the capabilities of Khotan.

Practicable passes into this country are now being sought, and it is hoped that the vast region of Chinese Turkistan will ere long be in communication with our provinces. A M. Lejean has sent home to the French Minister of Instruction an account of discoveries on the Persian Gulf which are said to be most startling. The particulars are not yet published.

From Abyssinia but little news reaches us. Dr. Beke has been giving a lecture on this country, with his view of the complications, which does not altogether coincide with that of some others. The captives are still captives, the king says, to prevent their falling into the hands of the rebels that beset him. The notices in English newspapers come before this potentate, and do not mitigate his peculiar temper. Mr. Rassam has contrived to send secretly some private letters to this country. He states that all are in good health, the consul is fettered, and he himself has a chain on his leg; but they are treated with consideration and kindness by the king!

The information about central Africa is at present small. A Dr. Ori, a Tuscan, who spent some time in the Soudan as a physician, is about to publish his journal. The Doctor is well acquainted with many African dialects. Of Dr. Livingstone we know little more than his letter to the Royal Geographical Society, which is referred to later. He has not written again; but Dr. Kirk had obtained information of his having advanced some little way beyond the confluence of the Rovuma and Loendi along the former river. Since this a report has come through the same gentleman of the death of the traveller. Time alone will show whether this is to be classed with many other reported deaths, or is the sad finale of a grand career.

M. du Chaillu has published an account of his last African expedition, in a work entitled 'A Journey to Ashango Land,' which deserves more than a passing notice, on account of its significant bearing upon the progress of scientific exploration. M. du Chaillu has learned that English readers are not easily satisfied with the accounts brought home by travellers, but that, in order to obtain permanent fame for the explorer, it is necessary that such accounts should bear the strictest investigation. Both to the general reader, and to the man of science, this book cannot fail to be amusing; to the former, because it tells of marvellous hair-breadth escapes, and flatters the vanity of the civilized white by showing his superiority of race, for the "Great Spirit" (as the author frequently tells his readers that he was called by the poor savages) with his musical boxes and scientific instruments, seems to have been regarded as a kind of angel come down from heaven armed with smallpox to punish and beads to reward, as it might please his will and pleasure. To the scientific reader the book,

coupled with the newspaper controversy on Natural History subjects between the author and Dr. Gray (*sic!* the former will pardon us if we borrow one of his ejaculations), exhibits the shrewd, adventurous traveller, driving his intellectual bargains, first abroad and then at home, and rendering an unconscious service to science by casting upon the public a heterogeneous mass of information from which the astute critic may easily sift the dross.

The author's "illustrious friends," Sir Roderick Murchison and Professor Owen, have served him well at home, and it is only a pity that they cannot induce him to share his African glories with one or more intelligent *whites* who would help him in the tropics in his photographic, trigonometrical, astronomical, and zoological labours, and would inspire confidence in much that he now writes, and which, although no doubt true, is looked upon with great suspicion.

Those hairy dwarfs, for example, have done less to establish our faith in the Darwinian theory than the contrasts which he unconsciously draws between the gorillas, the savages, his own "Commi boys," and himself! for if ever there was a complete gradation from man the brute to man the reasoner, there it is.

But we do not wish to underrate M. du Chaillu's labours. We are not merely ironical sceptics. He undoubtedly brought the wonderful gorilla to our doors, when it was a creature of fiction, and he stirred up other travellers and traders to seek the same zoological wonder with which some of our natural history museums are enriched. He brought or sent home other valuable specimens, has devoted his mind, as far as he was able, to the acquisition of scientific knowledge; has evidently controlled, to some extent, the desire to indulge in the narration of wondrous adventures, and seems to be gradually sobering down into an enterprising scientific traveller. We wish him a successful future; and next time he visits Africa, we trust that he may be more fortunate in his relations with the natives, and that he may not again lose his photographic apparatus.

Some time since we gave the arguments in favour of an open sea towards the North Pole. Dr. J. R. J. Hayes has advanced as far north as 81° 35′, the most northerly land ever reached by man; and hence he beheld a wide expanse of open sea. He was thus unable to continue the journey, but looks forward to making the attempt afresh, with the experience gained in his last expedition.

Proceedings of the Royal Geographical Society.

The last letter received from Dr. Livingstone was dated 18th May last, from Ngomano, at the junction of the Rovuma River with the Loendi. The traveller had arrived here from Milkindany

Bay, 25 miles to the north of the mouth of the Rovuma, whence he had been obliged to start, as he could find no path for the camels through the mangrove swamps at the mouth. Ngomano is 30 miles further than Dr. Livingstone had advanced in 1861. The chief here was friendly, and disposed to assist towards the journey to Lake Nyassa.

Dr. Mann, in discussing the Physical Geography of Natal, showed how the colony was suited by its configuration for the cultivation of sugar, coffee, arrowroot, pineapples, bananas, and oranges, on the coast; and wheat, potatoes, and other crops of a temperate zone, inland; but that it could never support the vine, because the clouds and moisture of the summer prevented the grapes from ripening. The coast has but one harbour, Natal, capable of receiving at present vessels of 700 tons burden, whilst it may be improved considerably. The warmth of the coast may be attributed to that of the current of water, of about 78°.

A paper by Colonel Tremenheere, R.E., "On the Physical Geography of the Lower Indus," gave rise to much discussion. After a description of the plain of Scinde, and its peculiar formation, without natural drainage, the Colonel entered upon an account of the gradual silting up of the Kurrachee harbour by the deposit of the Indus, borne northwards by the current. The various facts on which this theory depended, and the theory itself, were denied by the Chairman of the Scinde Railway, the Engineer of the Kurrachee Harbour, and others more or less interested in the matter; whilst Colonel Tremenheere was defended by General Sir W. Gordon.

Captain H. H. Godwin Austin, of the Trigonometrical Survey of India, described the Lake Pangong, in Thibet, which is about 100 miles in length, and is situated, 14,000 feet above the sea, in a valley to the south-east of the Karakorum.

Dr. Baikie, who died at Sierra Leone on his way to England to enjoy a few months repose, after many years' work in conciliating the natives on the Niger, left "Notes of a Journey from Bida in Nupe on the Niger to Kano in Hansa." This journey occupied nine months, and the records of it are sufficiently exact and explicit to enable Dr. Kirk to complete a map of the district. The country was generally fruitful, of various appearance, and inhabited by rude, but intelligent and kind people. The slave-trade seems to have somewhat diminished in some of these districts. The object of the expedition—the recovery of the papers of Vogel and Overweg—was not successful, but a clue was obtained to their present position.

The Bishop of Mauritius furnished a paper on "A Visit to the North-East Provinces of Madagascar," which narrated the events of a journey undertaken in 1865. The country is described as

beautiful and fertile, the harbours large and numerous, but the population small—the inhabitants being indolent, of a mild character, and subject to a dominant race—the Haves.

"A Diary of a Hill-Trip in Burmah" was furnished by Lieutenant T. H. Lewin, who in 1866 had to make his way with some danger through the Hill tribes up in the country lying between Bengal, Arrachan, and Burmah. These tribes are numerous and distinct from each other; of a Mongolian character, very barbarous, and speaking various dialects.

The discussion of a purely political topic—the choice of a site for the capital of India—was introduced by a paper by the Hon. C. Campbell, which recommended a spot on the Great Indian and Peninsular Railway, in the table-land of the Deccan on the Western Ghauts, 150 miles from Bombay. The climate is good for Europeans; it is within easy reach of the sea, though not too close; it is near the geographical and political centre of India, and has room for a European settlement around it. The principal drawback was a want of water, which might be supplied from a distance of four or five miles. The merits and demerits of Calcutta were discussed, as well as those of the site now indicated, and other localities were suggested; but the debate took almost entirely a political turn, and gave an opportunity to several eminent Indians to express their sentiments.

A letter from another African traveller, since dead, M. Jules Gérard, dated Mano, lat. 8° 10′ N., in the interior from Sherbro, on the west coast south of Sierra Leone, and supposed to have been written about a month before his death, from the upsetting a canoe in crossing the Jong river, gave some interesting details about the Kass country, which has never been visited by traders, but possesses abundance of ivory and cotton. M. Gérard had met with the usual obstructions offered by the chieftains on the coast.

'An Ascent of Mount Hood, in Oregon,' by the Rev. H. K. Hines, describes this mountain to be an active volcano, picturesquely situated, and of an altitude of 17,640 feet; a fact which is disputed. If, however, this be so, it is the highest mountain in North America.

A paper was read "On a Journey of Exploration in Eastern Oregon and Idalio," by Colonel C. S. Drew, U.S.A., and Mr. Robert Brown, F.R.G.S.; and at a subsequent meeting papers on subjects already treated of in former Chronicles; the "Exploration of the Purus River and the Rivers of Caravoza in Southern Peru," by Mr. W. Chandless and Don Antonio Ramondy respectively, were read and commented on.

9. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

Amongst the publications of the quarter most deserving of notice ranks the volume of the Palæontographical Society for 1865, which has lately appeared. It contains four parts of as many monographs, and although we can convey no idea of their value in this Chronicle, we must not omit to give an outline of the contents of each of them.

The first contribution consists of Part I. of a monograph of the Foraminifera of the Crag, by Professor T. Rupert Jones, Mr. W. K. Parker, and Mr. H. B. Brady. From a zoological point of view it may be regarded as a supplement to Messrs. Jones and Parker's paper on Arctic and Subarctic Foraminifera, in the 'Philosophical Transactions.' Geologically, its chief value is as a record of the exact position and relationships of the different groups (whether they be considered genera, species, or varieties) of these lowly organisms, deduced from careful investigations; and it appears that notwithstanding the extremely variable nature of Foraminifera, the authors are enabled to recognize different zoological zones by means of the facies of the assemblages of these fossils which occur in them.

The next memoir is the first part of Dr. Duncan's "Monograph of the British Fossil Corals," being a supplement to the one by MM. Milne-Edwards and Jules Haime. The introduction is a very complete essay on the anatomy, physiology, and classification of corals, and well deserves a careful study. The description of the corals of the Brockenhurst beds will no doubt form the basis of future researches into the relationships of this and other deposits, which have been variously termed Lower Oligocene and Upper Eocene. The mollusca show the Brockenhurst strata to be related to those of Latdorf; but the corals are distinct. Dr. Duncan is therefore probably right in suggesting that the coral-fauna of the former deposit belonged to an oceanic and reef area, and that of the latter to a coast line. This instalment concludes with a description of some additional species of corals from the Eocene of the Isle of Wight and from the London clay.

The introduction to the next monograph, "On the British Fossil Crustacea belonging to the order Merostomata" (Part I.), by Mr. H. Woodward, is of the same character as that to the one just noticed, and deserves the same praise. It is followed by a Bibliography of the order, which does credit to the industry and research of the author, while the description of *Pterygotus anglicus*, which completes this part, is remarkably exhaustive, and is illustrated both fully and well.

Mr. Davidson's contribution to this volume consists of the commencement of the Silurian portion of his monograph of British Brachiopoda, and includes descriptions of the Silurnia species of the families *Lingulidæ*, *Discinidæ*, *Craniadæ*, and *Spiriferidæ*. It is prefaced by a bibliography of the subject, and by an essay on the Classification of the Silurian Rocks, written by Sir R. I. Murchison. As it requires a close study to appreciate this monograph, it is sufficient to observe that it exhibits the scrupulous accuracy, both in description and illustration, that is so characteristic of all Mr. Davidson's works.

We think we perceive in this volume the evidence of some additional care in the getting up and printing, more especially of the plates; those illustrating Dr. Duncan's monograph being very favourable specimens of English lithography.

In a former chronicle* we recorded the discovery near Mons, by Messrs. Cornet and Briart, of a limestone containing Tertiary fossils, apparently of Bracklesham age, beneath strata belonging to the Système Landenien (Thanet sands). MM. Cornet and Briart have since continued their researches, and have given the results in a paper entitled "Notice sur l'Extension du Calcaire Grossier de Mons dans la Vallée de la Haine."† Not only are they confirmed in their original conclusion, but they are enabled to prove the extension of the fossiliferous deposit (calcaire grossier de Mons) for a considerable distance. The weak part of the evidence, namely, the proof of the age of the Landenian is not, however, strengthened by this memoir.

In a paper "On the Structure and Affinities of *Lepidodendron* and *Calamites*," published in the 'Journal of Botany,' Mr. Carruthers has given his reasons for regarding these plants as Cryptogams, more highly organized than any existing members of the class; and for considering merely analogical, the arrangement of their tissues to that of certain *Cycadeæ* and *Cactaceæ*. Mr. Carruthers warns geologists against taking for granted "that the known conditions of the living species of a genus are true also of the fossil members of the same genus;" and he cites the case of *Elephas primigenius* in illustration. This warning, coming from a botanist writing on such a subject, should make geologists suspicious of the probability of any of the numberless speculations on the climate and conditions of the Coal-measure period.

Dr. Hector, Director of the Geological Survey of Otago, has published a 'First General Report on the Coal Deposits of New Zealand,' the contents of which will probably surprise many unacquainted with the recent Government publications relating to the geology of the colony. Both brown coal and true coal appear to

* 'Quart. Journ. Science,' No. XI. p. 417.

† 'Bull. Acad. Roy. Belgique,' 2me série, vol. xxii.

be abundant in the north island, as well as in the south. Economically, the latter is of course by far the more important, and it is satisfactory to find that it makes a remarkably good steam-coal, notwithstanding its brittleness and its Mesozoic age, while Dr. Hector estimates its quantity at not less than four thousand millions of tons.

Another colonial publication which deserves mention is a memoir on the 'Physical Geography, Geology, and Mineralogy of Victoria,' by Mr. Selwyn, the Director, and Mr. Ulrich, one of the Geologists, of the Geological Survey of the Colony.

M. Tournouër, who has so long devoted his attention to the geology of the basin of the Adour, has lately published a memoir on the Tertiary deposits of the upper valley of the Saône, in the twenty-third volume of the 'Bulletin de la Société Géologique de France.' In this memoir, the author gives the results of a most careful and extended investigation into the geological structure of the district treated of; and gives, with considerable clearness, his views of the sequence of events which have produced the various phenomena which we are now called upon to interpret. These events appear to have been as follows:—At the termination of the Cretaceous period, or even before then, the deposits previously formed were upheaved, and lakes were hollowed out in the surface of the Cretaceous beds. In these lakes were deposited, during a period of oscillations of level, the strata characterized by *Limnea longiscata*, those by *Bithynia Duchasteli*, and those by *Helix Ramondi*. To this epoch succeeded a long period of calm, during which the Upper Miocene marine strata were deposited. After this, occurred another upheaval, followed by the establishment of another lake-period, in the deposits of which are found the remains of a fauna of the time of *Mastodon Arvernensis* and *Elephas meridionalis (?)*. Then followed another change, coupled with a third upheaval, and the destruction of the last system of lakes; and during this period was formed the drift with *Elephas primigenius*. Hence we get to the existing order of things, and the confinement of the waters of the several rivers within their present limits.

We must not omit to record the publication during the past quarter of the Explanation to Sheet 33, of the Geological Survey Map, entitled 'The Geology of East Lothian, including parts of the counties of Edinburgh and Berwick,' by Messrs. H. H. Howell, A. Geikie, and John Young.

We have little space left to discuss the many papers contained in the last three numbers of the 'Geological Magazine;' but a few are too important to be passed over in a Chronicle of Geology. Mr. Carruthers's paper, "On some fossil Coniferous Fruits," is of considerable consequence, both geologically and pa-

læontologically; from the former point of view because he shows that two species of cones, hitherto considered to be of Cretaceous age, are really of Tertiary date; and from the latter because he considers these, and some other cones, to be truly Coniferous, instead of Cycadean, as determined by Lindley and Hutton. Mr. Carruthers also departs from custom in referring the different species of cones found in the Secondary and Tertiary deposits to one group, for which he uses the general generic term *Pinites*, while more daring botanists have had no hesitation in assigning them to "the various sections, or so-called genera, into which *Pinus* is divided."

A very sensible paper, in the January number, "On Denudation, with reference to the Configuration of the Ground," by Mr. A. B. Wynne, inculcates the maxim that "all the forms of the land cannot be fairly attributed to any one kind of denudation with which we are acquainted;" and that the similarity of the general results involves their origin in some obscurity, "which may lead to error, if a prejudice exist in favour of either marine or subaerial agency." In the same number is a valuable abstract of a Danish memoir on Crinoids, by Dr. Lütken, which especially affects palæontologists, as it treats of the classification of the group generally; but there is one structural point which likewise demands consideration:—some Crinoids, especially Palæozoic forms, possess a central opening, terminating a proboscidean tube; this has generally been regarded as the mouth, and any other aperture as the vent. Dr. Lütken, however, shows that in the existing sea-lilies a proboscidean mouth does not exist, but that the intestine *always* ends in a short or long proboscidean tube; and he therefore considers that this is most probably the anus. In the recent *Actinometra* the mouth is eccentric, so that there is no reason why this should not have been the case in the fossil species; indeed, "it is the form, and not the place, that must decide if it is the anal-tube or the mouth."

The February number is full of interesting matter. Professor Owen describes the jaws and teeth of Cochliodonts; and Professor Huxley a new reptile (*Acanthopholis horridus*) from the chalk-marl of Folkestone, its stratigraphical position being illustrated in a paper by Mr. Etheridge. Professor John Morris gives some interesting information on the occurrence of "Greywethers" at Grays, Essex, which has not been generally noticed before. Then there are two controversial papers, one "On the systematic Position of Graptolites," by Mr. Carruthers, in which the author favours the view of their Polyzoan affinities; and the other "On the alleged Hydrothermal Origin of certain Granites, &c.," by Mr. David Forbes, in which the author impugns the conclusions at which Mr. James Geikie had arrived in his paper

noticed in our last Chronicle,* which he supplemented by a note in the December number of the 'Geological Magazine.' Mr. Forbes is very hard on Mr. Geikie's Chemistry, Mineralogy, and *Petrology*. We should imagine, however, that Mr. Forbes would hesitate before seriously opposing the "hydrothermal" theory; and, in fact, his hesitation is so great as to lead to contradiction (*see* p. 58). It may be that Mr. J. Geikie's language is loose; but a good cause has often an unskilful advocate. However, the moral of Mr. Forbes's criticisms is doubtless true, namely, that Mr. J. Geikie has been too eager to generalize on data, and perhaps with knowledge, insufficient for the task.

Proceedings of the Geological Society.

The number of the Geological Society's 'Quarterly Journal' for the past quarter contains few papers; but these are chiefly of considerable merit.

Professor Huxley's description of "some remains of large Dinosaurian Reptiles from the Stormberg Mountains, South Africa," is of considerable interest, on account of the uncertainty of the age of the fossiliferous strata occurring in that region. The most important of these remains belong to a new genus, named *Euskelesaurus* by Professor Huxley, having affinities with *Megalosaurus* and *Iguanodon*; but no very definite conclusion can be drawn from them respecting the age of the strata from which they were obtained, as Dinosaurian reptiles have been discovered throughout the Mesozoic formations—from the Triassic to the Cretaceous inclusive. Professor Huxley also remarks that "the affinities of the Thecodonts with the Dinosauria are so close that no one could be surprised at the occurrence of the latter reptiles in rocks of Permian age." According to Mr. Bain, the strata forming the Stormberg mountains are "piled conformably above the Karoo-beds, which have yielded the Dicynodonts and so many other remarkable true reptiles and Labyrinthodonts," so that future discoveries of fossils in the Stormberg rocks may enable us to place, at least, an upper limit to the possible age of the *Dicynodon*, about which there has been so much discussion.

The paper "On Marine Fossiliferous Secondary Formations in Australia," by the Rev. W. B. Clarke, is worth considering, as a great deal of speculation on the cause of the Mesozoic facies of the recent Australian fauna has been based upon the supposed absence of such deposits from the Australian continent; but we must refer our readers to the paper itself for the evidence brought forward by the author.

The most important paper in the journal is that by Dr. Duncan,

* 'Quart. Journ. Science,' No. XIII., p. 121.

"On the Madreporaria of the Infra-lias of South Wales," as in it the author describes the occurrence of a coral-fauna, new to Great Britain, occurring in deposits of Liassic age at Brocastle, Ewenny, Sutton, Southerndown, &c., near Bridgend. Before the discovery of these corals, very few were known to occur in England between the Keuper and the zone of *Ammonites Bucklandi*, and as regards the number of species, they bore no relation to that of the associated mollusca. We have now, however, 26 new species from Brocastle, and 7 from the Sutton series, besides 5 common to the former locality and the zone of *Ammonites Moreanus* in the Côte d'Or and its equivalent beds, and 3 Triassic species from the Sutton stone, already described by Laube; making, in all, 41 species.

The conclusions drawn from these entirely new data must have a high interest for geologists who have taken part in the vexed question of the lower limit of the Liassic series. As will be seen by the title of his paper, Dr. Duncan adopts the term Infra-lias, used by continental geologists; but he makes the very suggestive remark—that "the Madreporaria abound at the base and at the upper part of the Infra-liassic series . . . . and that as a whole, the coral-fauna of the Infra-lias is more distinct from that of the true Lower Lias than the coral-fauna of any one of the Oolitic beds is from that of another." He correlates the Welsh strata in question with "the upper beds of the French and Luxembourgian Infra-lias," and we have seen that three Triassic species have lingered even so late as to be found at Sutton. It therefore becomes interesting to know how many Triassic forms are found in the beds at the base of the continental Infra-lias, because on this will depend the verdict to be given on the applicability of the term Infra-lias, from the evidence of the corals. But whatever name we use, we have recorded in this paper the very important fact that these rich coralliferous beds of Wales are the equivalents of the upper portion of the continental Infra-lias, namely, of the Calcaire de Valogne, the zone of *Ammonites Moreanus*, and the Grès Calcareux, which are superimposed on the equivalents of our zone of *Ammonites planorbis*; consequently the Welsh beds must be more recent than that zone.

In a paper on the structure of the Xiphosura, Mr. H. Woodward discusses the relations of the Palæozoic genera *Eurypterus* and *Pterygotus* to the existing genus *Limulus*. At first sight the affinity of the recent with the fossil types does not appear very evident, and, even when the resemblances are pointed out, it does not seem to be striking. But recent discoveries have shown that these are the extreme members of a long series of forms, and as each gap has been filled up, the comparison has, of course, become more easy and natural, until now Mr. Woodward considers the

materials at his command sufficient to form the basis of a scheme of classification. He proposes to treat the groups Eurypterida and Xiphosura as suborders of Dr. Danas's order Merostomata, the former including the genera *Eurypterus*, *Pterygotus*, &c., with several forms which have a more limuloid aspect, notably *Hemiaspis*.* In the suborder Xiphosura he includes the recent genus *Limulus*, and (what is very important) two Carboniferous genera, namely, *Belinurus* and *Prestwichia*, which are, together, represented by six species. The distribution of the fifteen species of *Limulus* is worth notice, as showing the suborder to have been represented in every great period *since* the Carboniferous, there being one species known from the Permian, one from the Trias, seven from the Oolites, one (doubtful) from the Chalk, and one from the Tertiary; and there are four recent species.

A short paper by Dr. Duncan, "On some Echinodermata from the Cretaceous Rocks of Sinai," is of some interest, as showing that these fossils prove (1) that the Sinaitic strata are the equivalents of our Upper Greensand; (2) that they are on the same horizon as the Cretaceous strata of South-eastern Arabia, and of Bagh on the Nerbudda; and (3) that the conclusions drawn by Dr. Duncan from the fossil Echinoderms of the latter localities † are probably well founded.

Mr. J. W. Flower's paper "On some Flint Implements lately found in the Valley of the Little Ouse river at Thetford, Norfolk," is a record of the discovery of implements of the St. Acheul type, in gravel-beds in that locality, situated in a position analogous to that of other implement-bearing deposits. Beyond this, however, it is of considerable interest, as the author's researches have led him to doubt the probability of Mr. Prestwich's conclusion that these gravel-terraces were brought into their present position by river-action. We cannot give all his arguments; but one, especially drawn from the case recorded in the paper, deserves attention. Flint implements have been found in gravel-deposits in three different river valleys, very near to each other,—namely, of the Waveney, the Little Ouse, and the Larke. The two former rivers rise in a marsh within a few yards of one another, and then flow in nearly opposite directions; and while at the present day their volume, even at their highest floods, is quite inadequate to do the work required of them by Mr. Prestwich's theory, in their narrow watershed we can find no high land from which the snows of former periods could have given forth the torrents of water invoked by Mr. Prestwich in the case of the valley of the Somme. Other arguments are also used by Mr. Flower with much ingenuity, and his paper deserves the careful consideration of "Quaternary" geologists.

* See 'Quart. Journ. Science,' No. IX. p. 107.
† See 'Quart. Journ. Science,' No. IX. p. 105.

The last paper we have to notice is a very short one by Professor W. C. Williamson, "On a Cheirotherian Footprint from the Base of the Keuper Sandstone of Daresbury, Cheshire," which is of more importance than its title indicates, as the footprint is more Cheirotherioid than Cheirotherian, and is "distinctly that of a *scaly* animal." The following conclusion is also at variance with the title:—"Had the impression not exhibited the scaly structure, it would probably have been described as 'Cheirotherian,' but I do not believe that it belonged to a Batrachian animal. It is Saurian, if not Crocodilean, in every feature, and as such, constitutes an interesting addition to the palæontology of the English Keuper."

We are sorry to be obliged again to chronicle the death of two eminent geologists, namely, Mr. James Smith, of Jordan Hill, F.R.S., F.G.S., &c., a very old and eminent explorer of Postpliocene or Quaternary deposits; and Professor J. A. E. Deslongchamps, of Caen, a Foreign member of the Geological Society, and one of the foremost of French palæontologists; both of whom have become lost to us after a long life of devotion to our science. It is with different feelings that we record the untimely death of Mr. F. J. Foot, M.A., &c., in an effort to save the lives of two persons from drowning. Mr. Foot was on the staff of the Geological Survey of Ireland, and was a very promising and active botanist and geologist.

The Council of the Geological Society have awarded the Wollaston gold medal to G. Poulett Scrope, Esq., M.P., F.R.S., F.G.S., &c., in recognition of the highly important services he has rendered to geology by his examination and published descriptions of the volcanic phenomena of central France, and by his works on the subject of volcanic action generally throughout the world; and the balance of the proceeds of the Wollaston Donation Fund to Mr. W. H. Baily, F.G.S., to assist him in the preparation and publication of an illustrated catalogue of British Fossils.

10. MINING.

The continued state of extreme depression which prevails in the mining districts renders our chronicle a sad one. In Cornwall and Devonshire more than half of the mines—that is, nearly 300—are now idle, which were in active operation a few years since. Careful examinations made in each of the mining districts of south-western England enables us to give the following list, as a very close approximation, to the real numbers of the miners who have emigrated.

From Tavistock and Ashburton Districts	. . .	691 Men.
„ Liskeard	. . . . .	100 „
„ St. Austell and St. Blazey	. . . . .	275 „
„ Redruth and St. Agnes	. . . . .	300 „
„ Camborne	. . . . .	150 „
„ Hayle	. . . . .	550 „
„ St. Ives and Lelant	. . . . .	150 „
„ St. Just	. . . . .	600 „
„ Helston and Wendron	. . . . .	100 „
„ Marazion and Tremayne	. . . . .	450 „
		3,366 Men.

It must be remembered that these are able-bodied men, the youngest and most active of the mining population. About a thousand of these have found employment in the collieries of Wales and Scotland, and on the lines of railway which are now in progress—especially around the Metropolis. From the largest copper-mining district of Cornwall we hear of three mines, paying about 1,000*l.* per week in agency and labour, which are continuing to do this at an actual loss of 15,000*l.* a year. Should these mines succumb beneath the pressure of the times, the withdrawal of the 52,000*l.* now distributed as wages, would spread ruin on every hand.

Lead-mining is not affected to the same degree as tin and copper, although the condition of the metal market is influencing even the Lead-mines.

Coal-mining is, and has for some time, been very brisk; while, on the other hand, the iron trade cannot recover its position.

The returns of our mineral produce for the year 1866 are not yet complete. They are, however, sufficiently advanced to enable us to state that the production of Tin will have been unusually large, although nearly every ton of tin ore will have been sold at a loss; of Copper ore, from British mines, there will have been a falling off; but the importations of Foreign Copper will have been large. Lead and the other metalliferous minerals will remain much as they were in 1865. Nearly, if not quite, one hundred millions of tons of Coals will have been produced in the United Kingdom.

In the process of coal-mining, this quarter will be marked by the terrible accidents, by explosion—at the Oaks Colliery in the Barnsley district, and at the Talk-o'-the-Hill, near Hanley, in Staffordshire, by which nearly four hundred lives have been sacrificed. These casualties have naturally directed attention strongly to the system of colliery inspection. We do not learn whether it is the intention of the Government to propose any measures calculated to secure greater attention in the particulars of ventilation and lighting.

In the midst of the extreme depression which prevails in our metal mines, two members of the House of Commons talk of new legislation—one bringing in a bill to rate metal mines to the poor;

the other proposing to found a bill for their better regulation, on the report of Lord Kinnaird's Commission. Upon reflection, we should hope both these measures will be postponed.

We have, from time to time, noticed the coal-cutting machines which have been introduced. We have now to record an important movement in connection with them. A committee, consisting of some of the largest coal proprietors of Lancashire and Cheshire, have offered three prizes, of the respective values of 500*l*., 200*l*., and 100*l*., for the first, second, and third best machines for the cutting of coal. The machines must be adapted to the following requirements:—Thickness of seams, from two to nine feet. The dip, or inclination, from horizontal to an angle of 20°. Maximum size of tub or wagon used in the mines, three feet six inches by three feet, and three feet in height. Gauge of road, from one foot six inches to two feet three inches. It is considered desirable that the machine should be as light and as easily moveable as possible.

The committee express their belief that compressed air is the proper motive power for working coal-cutting machines. We hope this does not mean, that they exclude machines worked by water pressure from their consideration. The facility with which power is transferred, with scarcely any loss by water, as compared with the great loss when air is employed, renders it advisable that water pressure should be equally considered. Inventors must furnish machines not later than the 1st of November in the present year. We quite expect from this, that we shall soon find coal-cutting machines in general use in our collieries.

A successful application of the Electric Telegraph has been made by Messrs. T. B. and W. B. Brain, in the Trafalgar colliery in the Forest of Dean. A great difficulty arose in the conveyance of coal from the workings to the shaft, owing to the declivity of the seam under work. Indeed, the steepness was such, that the ordinary method of hauling became impracticable. To meet this difficulty the engine at bank was brought into requisition,—to which was applied a length of chain reaching to the end of the workings, the shaft being 200 yards deep, and the dip workings extending to a considerable distance. To ensure safety, instantaneous communication was necessary, and electricity was thought of. An electric bell is placed in the engine-house, and another near the top of the dip-workings; these are connected by wires carried down the pit and continued along the road. The great danger was the liability of injuring the men, during the rapid ascent or descent of the trucks. To avoid this, "electrical tappers" are placed along the road, and thus at any point a man can signal to stop or start the engine. The old mode of signalling between the "hanger-on" and the engine-man has been superseded by this new arrangement. An instrument is placed in front of the engineer,

and at the bottom of the shaft the hanger-on is provided with a pair of electrical tappers, coloured respectively white and red. The white tapper being touched, the bell is rung in the engine-house, and the words "Go on" appear on the dial; on touching the red tapper, the bell is struck as before, and then the word "Stop," in white letters on a red ground—as indicative of danger—appears.

The salt-mines of the Nevada Territory are the most considerable in the United States. A single bed of rock-salt occupies a superficial space of 52,000 acres, and produces annually two million bushels of a mineral which gives 95 per cent. of pure salt. If the ground is pierced to the depth of from 250 feet to 300 feet saline water rises so rapidly and with such force that all the workings are interrupted.

Coal is stated to have been discovered in India, at Nursingpore, in the immediate neighbourhood of the Great Indian Peninsular Railway. This discovery, if the quality of coal is good, is of great importance.

In a communication "On Gun Cotton and its Use in Blasting," made by Messrs. T. Prentice and Co., to a contemporary journal* they state:—"We have lately prepared a very condensed charge, one inch of which will be found equal to six ounces of powder. Of our $1\frac{1}{4}$-inch diameter, five inches in length are equivalent to one pound of powder, and can be supplied at $4\frac{1}{2}d$. By the use of this in hard granite rock, a large saving in boring is effected: the charges slip readily into the hole, leave no residue on the side, and only require the fuse to be connected with the uppermost piece. The total absence of smoke, comparative freedom from danger, portability and convenience of form, combined with saving in labour and material, are advantages which are bringing Gun Cotton largely into use."

We quote this passage, and can, from our own knowledge, confirm much that is stated. Upon one point we must, however, remark. That there is a total absence of *visible* smoke is admitted on all hands; but in the combustion of Gun Cotton, gases are formed, which, floating in the atmosphere of a close end in a mine, may exert a most injurious effect on the miner, should he incautiously resume his work too speedily after the blasting of a hole.

Mineralogy.

In the February number of the 'Philosophical Magazine,' Mr. David Forbes, F.R.S., continues his "Researches on the Mineralogy of South America." The present paper contains a sketch of the "General Mineralogy of Chili," the author having spent four years

* 'Mining Journal.'

in examining the country and visiting its chief mineral localities. Some idea of its riches may be gained from Forbes's catalogue of the species which have hitherto been discovered, amounting to upwards of two hundred, the greater number of which occur in the intrusive rocks and their associated mineral veins. An examination of this list shows that many species which are abundant in mineral deposits in other parts of the world, are here found only in insignificant quantity, while many others are altogether absent. The minerals are classified according to their geological occurrence, the richest repositories being what are designated as the "post-oolitic diorite eruptions." From the author's observations, it appears that the occurrence of the Chilian minerals, so far from being casual or accidental, bears a definite relation to the rocks in which they are found, "similar minerals, or classes of minerals, accompanying the eruption of similar rocks;" and even where the same species occurs under different conditions, each occurrence is marked by distinctive characters of its own, either chemical or crystallographical.

The same able mineralogist has commenced in the 'Chemical News' a series of articles "On the Application of the Blowpipe to the Quantitative Determination or Assay of Certain Metals." These papers, which will serve as an introduction to the author's forthcoming treatise on the subject, cannot fail to prove of essential service to the mineralogical student. While noticing the recent literature on the Blowpipe, attention should be directed to Professor Theodor Richter's essay on "The Blowpipe, and its Application in Chemical, Mineralogical, and Assaying Investigations" (Das Löthrohr und seine Anwendung bei Chemischen, Mineralogischen und Docimastischen Untersuchungen). This essay, which will be read with much interest,—Professor Richter being himself a perfect master of the Blowpipe,—appeared in the 'Festschrift,' published a few months back in commemoration of the hundredth anniversary of the foundation of the Freiberg Mining School; and our English readers are referred to an analysis of the paper in an article, "On Mining Education in Germany," which appeared in a recent number of the 'Journal of the Society of Arts.'*

Among the various substances which pass in commerce under the general name of Jade or Nephrite, is a light-green mineral from Easton, in Pennsylvania, which has recently been examined by Dr. Emmerling, of Freiburg.† Except, perhaps, in point of toughness, it possesses none of the properties of true jade, and especially lacks the characteristic splintery fracture; whilst in chemical composition it appears to be equally distinct, consisting of certain silicates and carbonates, the relations of which may be

* *Op. cit.*, January 11, 1867, p. 113.

† 'Neues Jahrbuch für Mineralogie, u.s.w.,' 1866. Heft 5, p. 558.

best shown by transcribing the Doctor's somewhat unattractive formula:

$$\text{“18 HO + 5 Ca O, } CO_2 + 7 \text{ RO, Si } O_2 + 5 \text{ } R_2O_3, \text{ Si } O_2 + 3 \text{ (Mg O)}_3 \text{ (Si } O_2)_2\text{.”}$$

Until more shall be known as to the history of this complex mineral, Dr. Emmerling proposes to distinguish it as *Pseudonephrite.*

The eminent Russian mineralogist, M. Kokscharow, has published the results of his observations “On the Crystalline System and the Angle of Sylvanite” (Ueber das Krystallsystem und die Winkel des Sylvanits).* This mineral so rarely occurs crystallized, that the system to which it belongs has always been questionable, Mohs having described it as rhombic, while G. Rose regarded it as oblique. Availing himself of some well-defined crystals recently come into his possession, the author has undertaken a complete investigation of the mineral, the results of which confirm Rose's determinations as to the oblique character of the crystals.

In a paper “On certain Phenomena observed in Natrolite” (Ueber einige Erscheinungen, beobachtet am Natrolith),† Professor Kenngott describes the singular behaviour of this mineral in relation to heat. When small colourless transparent crystals of natrolite are slowly heated, they gradually become white and opaque, without losing their crystalline form; but if further heated, under proper conditions, these altered crystals lose their colour and opacity, and return to their original condition. The author explains these appearances by supposing the mineral to be constituted according to the following expression:—

$$\text{“Na O, 2 HO + } Al_2 O_3, \text{ 3 Si } O_2\text{.”}$$

It will be observed that the soda, instead of being combined with a portion of the silica, as usually represented, exists in the state of a free hydrate, and the first effect of exposure to heat is to expel the water from this hydrate, thus leaving the soda free, the molecular change induced giving rise to the opacity; but when the altered mineral is further heated, the soda combines with the silicate of alumina to form a clear fusible compound; and hence the crystals regain their transparency. The author perceived that if this view of the constitution of natrolite be correct, the mineral in its natural state should give an alkaline reaction, from the presence of free hydrate of soda; and this sagacious inference was fully verified by his experiments. When powdered natrolite is moistened with distilled water, it gives a strong red tint to turmeric paper, and restores the blue colour to reddened litmus.

* ‘Mélanges Physiques et Chimiques,’ tome vi., liv. 5, p. 537.

† ‘Neues Jahrbuch für Mineralogie, u. s.w.,’ 1867, Heft 1, p. 77.

Kenngott's observations are of considerable interest, from their bearing on the constitution of other zeolitic minerals.

Among the researches conducted in the laboratory of Zurich, the results of which have lately been published in the 'Journal für praktische Chemie,' we notice several mineralogical investigations. Herr Städeler has chemically examined the topaz, and the silicate of iron called lievrite; while Dr. Wartha has investigated the minerals pennine and wiserine. The last of these papers is of interest as showing the folly of rashly instituting new species. *Wiserine* is a Swiss mineral occurring in pale clove-brown tetragonal crystals, resembling those of zircon. Its chemical composition was not well known, but it was supposed to contain silica and titanic acid. This is, however, entirely disproved by Dr. Wartha's analysis, which shows it to be a phosphate of yttria, agreeing with the Norwegian species known as *Xenotime*. Its occurrence is notable as being the first yttria-bearing mineral found in Switzerland.

Several other papers in the same journal merit the attention of the mineralogist. The green colour presented by many sandstones, marls, and other sedimentary rocks, is usually referred to the presence of disseminated granules of *glauconite*—a mineral which, although by no means confined to any particular geological age, is especially abundant in certain Cretaceous deposits, such as the typical "greensand" of our own country. So difficult is it to dissociate these mineral-grains from the rock in which they are embedded, and so readily do they suffer alteration by the action of decomposing influences, that the analyses which have from time to time been published present discrepancies of such magnitude, as to induce Dr. Haushofer to thoroughly examine the mineral with a view to determine its true chemical composition. In his paper "On the Composition of Glauconite,"* he publishes no less than seventeen original analyses of this mineral from different Bavarian rocks, obtained through Professor Gümbel. From these researches he concludes that all the varieties of glauconite are referable to a single species, but that their composition is not reducible to one general expression. The author calls attention to the relation between the constitution of the mineral in question and that of certain varieties of seladonite, or green-earth; at the same time expressing a belief that many so-called chloritic rocks are in reality glauconitic. In all cases the mineral appears to be a secondary product, derived from the surrounding rocks. According to Ehrenberg the grains often consist of the casts of microscopic foraminifera, and hence it is usually assumed that organic substances have been concerned in the formation of the mineral; an assumption which Haushofer is led to doubt, from the striking paucity of organic remains in glanconitic

* 'Journ. für praktische Chemie,' 1866, No. 6, p. 353.

rocks. All the analyses show a notable proportion of potash, and the author refers to the benefits which plants must derive from growing upon soils resting on rocks rich in glauconite.

As the effect of heat on minerals is always a subject of much interest to the geologist, we call attention to Dr. Elsner's researches "On the Behaviour of certain Minerals and Rocks at a very high Temperature" (Ueber das Verhaltung einiger Mineralien und Gebirgsarten bei sehr hoher Temperatur).* The investigations were conducted in the furnaces of the Royal Berlin Porcelain Manufactory, at temperatures between 2,500° and 3,000° Centigrade.

In the Chronicles of last quarter we described what was called the "Colorado Meteorite." Another mass has since been discovered in the same territory, and it is therefore proposed to name each after its special locality, distinguishing the older meteorite as the "Russel Gulch" iron, and the recently discovered one as the "Bear Creek" iron. The latter consists of nickeliferous iron, associated with magnetic pyrites, schreibersite, and other meteoric minerals. The following is Professor J. Lawrence Smith's analysis of the iron:—†

Iron	83·89
Nickel	14·06
Cobalt	0·83
Copper	Minute quantity.
Phosphorus	0·21
	98·99

In the same Journal Professor C. U. Shepard proposes a new classification of meteorites.

Those who are acquainted with Dr. Viktor von Lang's high position as a crystallographer and physical optician, will welcome the appearance of his recently-published 'Treatise on Crystallography.' ‡ To most of our English readers Dr. Lang will probably be well known, from his former connection with the British Museum, and from the Memoirs which he published in conjunction with Professor Maskelyne. He resigned his appointment in this country for a professorship in the University of Grätz, and he at present occupies a chair in the University of Vienna. The work before us is a comprehensive treatise based on Professor Miller's system of crystallography; but, being entirely free from the popular element, it will probably be read with profit only by the advanced student.

In the district of Beechwood, Sebastopol Creek, in Australia, a new diamond has been found, weighing a carat and one-eighth. It

* 'Journ. für praktische Chemie,' 1866, No. 21, p. 262.

† 'Silliman's American Journal of Science and Arts,' Jan., 1867, p. 66.

‡ 'Lehrbuch der Krystallographie,' von Viktor von Lang. 8vo. Wien, 1866, pp. 358.

was discovered at the depth of 250 feet, amongst little blue and white topazes, hyacinths, zircons, tourmalines and stanniferous sands.

The phosphoresence of hexagonal blende has recently claimed the attention of M. Edmond Becquerel. Although no really new fact has been discovered, a step has been taken towards establishing the relation existing between the solar phosphorescent rays and the other rays of the solar spectrum. We refer our readers to the original paper.*

A Californian newspaper informs us that about three miles north of Ione in that country, there is an isolated mountain, which might be called a mountain of Agates, so thickly is it covered with those concretionary masses. They are described as being like large potatoes, generally of an oval, but sometimes of a globular form. When cut and polished, it is said they are of exceeding beauty.

A communication has lately been made to the Academy of Sciences of Paris, on the remarkable Selenides which were discovered some six years since at Cacheuta, in the province of Mendoza, at the lower part of the Andes, and which have lately been examined by M. Domeyko. The seleniferous minerals appear to be of three varieties, in combination with silver, copper, and lead. The percentage of selenium varied between 22·4 and 30·8 per cent.

Metallurgy.

The past quarter has been singularly barren of results in any of the processes of smelting or preparing metals. The two following notes are the only ones, indeed, which even the scientific periodicals of Europe enable us to give.

At the meeting of the Chemical Society, on February 7th, Dr. Matthiessen read an interesting communication on Alloys. Many of the examples given appear to promise to be of much practical utility. This paper has been more fully noticed in the report of the Proceedings of the Chemical Society.

M. H. Caron has been making some interesting experiments on the Absorption of Hydrogen and Oxygen by Copper during fusion. Many of the results are of considerable interest; but as the investigation is incomplete, and as M. Caron promises to publish shortly the result of his experiments relative to the action of carburetted hydrogen and of carbon upon copper in fusion, we postpone our more detailed notice until the whole question is before us.†

* See 'Les Mondes,' tome xii., p. 521.
† See 'Les Mondes,' vol. xiii., p. 42.

11. PHYSICS.

LIGHT.—Some experimental researches on the indices of refraction of saline solutions have been communicated by M. Le Verrier to the Academy of Sciences. His aim has been to ascertain whether the law, as laid down by Biot and Arago relative to gaseous mixtures, was equally true for liquids. Having experimented upon 153 solutions, he arrives at the following conclusions, giving at different temperatures for each body, its chemical composition, specific gravity, and index of refraction.

The number representing the index of refraction varies according to the temperature. From 50° F. to 203° F. this variation often attains the hundredth part, and is greater in proportion as the liquid is the more concentrated. Its refringent power diminishes when the temperature is increased, and this diminution from 50° to 203° is about the thousandth part. The dispersion also diminishes with the temperature. In the same interval the distance between the two lines A and B of the spectrum may present a difference of a thousandth part. The law of Biot and Arago, that the index of a mixture of two gases is the mean between that of the two elements which constitute it, is therefore not strictly true in its application to liquid mixtures, but it may be regarded as a very close approximation, differing little from the truth, for a great number of saline solutions.

When Nicol's prisms are used as polarizers or analyzers in delicate optical measurements, an anomaly is frequently remarked: the azimuths of extinction do not occur at a distance of 180°. The error can amount to several tens of minutes. This error would be fatal to the use of the Nicol's prism if the cause could not be discovered, diminished, and remedied. M. Cornu first pointed out this cause, and he has given the following explanation:—The axis of rotation of the prism, or rather that of the instrument which carries it, does not coincide with the plane of the principal section; hence the ray which traverses takes different directions in the prism according to the azimuth, and the polarization to which it is subject is not parallel to the plane of the optical symmetry of the crystal. When the lines of entry and emergence of the prism are quite parallel, it can be regulated by trial; in general the error will be only alternated and not annulled; but it may be eliminated in proceeding by crossed observations. In fact, it is easy to demonstrate by a very simple calculation and by direct observation, that the error e of the normal azimuth is given by the formula

$$e = A(z + a);$$

A and e being the contents; z the observed azimuth, it is easy to

deduce that the mean of the readings of the azimuths, which should strictly differ by 180°, gives, after the subtraction of 90°, the real azimuth. The error is eliminated of its own accord, if we choose for the measurements of the azimuths the mean of two positions of extinction, whether for the analyzer or for the polarizer.

M. E. Javal has described a new instrument which he calls the *Iconoscope*, intended to give relief to plane images examined with the two eyes. From the description we judge that this is an instrument similar to one which has long been known in England. It consists of an arrangement of prisms so placed that each eye receives an impression from the same point of view. On looking through the instrument at a picture, the eyes always preserving the same amount of convergence and being thereby unable to judge that the objects are on a flat surface, the painting has a semblance of relief.

HEAT.—In the second part of a memoir "On the Changes of Temperature produced by the Mixture of Liquids of different Natures," recently published by Messrs. Bussy and Buignet, the following very important conclusions are arrived at:—1. In all the cases under examination, with one sole exception, the calorific capacity of the mixture is a little superior to the mean capacity of the elements. 2. By a singular opposition, the liquids for which the increase of bulk is the most considerable, are exactly those which develop most heat at the moment of their union, such as ether and chloroform, alcohol and water, sulphuric acid and water. Meanwhile, the only instance hitherto noticed of diminution of bulk is the mixture of *chloroform* and *sulphide of carbon*, the decrease of temperature taking place at the moment of the union. 3. Independently of the loss of heat resulting from the changes of volume, there exists a cause which produces alone an absorption of heat—an absorption which can be sometimes equal and even superior to the heat given out by the combination of the liquids. This cause, perhaps, may proceed from the separation of the homogeneous particles necessary for the *diffusion* of the liquids.

M. Fizeau has continued his researches on the dilatation of crystals. He has experimented upon several series of salts presenting a great analogy with each other—such as chlorides, bromides, and iodides—expecting that this analogy would be manifested by the manner in which crystals are influenced by the action of heat. His previsions are in general confirmed, and in the course of his studies he has discovered a singular anomaly, and one which constitutes a real discovery. While the coefficient of dilatation of all the chlorides, bromides, iodides, is positive, in the same manner as it is for all substances experimented upon up to the present day, the

coefficient of dilatation of *iodide of silver* is alone negative, so that this salt, instead of dilating, really contracts. Raised to a temperature of 40° C., the coefficient is −0·00000139. This coefficient is besides variable with the temperature and the direction in the interior of the crystal. In the direction in which the contraction is greatest, parallel to the axis, it is the $\frac{1}{7000}$ part for 100° C., about a tenth of the dilatation of mercury.

M. Matteucci has experimented on the adhesion of air to metallic surfaces. He heats plates of platinum in a current of oxygen or hydrogen; then he places them, while yet hot, in a closed apparatus containing one of the above-named bodies. Immediately there is a diminution of volume of the gases, and a formation of aqueous vapour by the combination of oxygen and hydrogen. It may happen that in the case of platinum the adhesion of the gases is not only to the metallic surface, but also in the interior of the metal itself. Metallic platinum is generally formed by hammering spongy platinum—a substance which has the property of exciting the combination of certain gases; hence it will not be unreasonable to believe that the molecular interstices opened by the heat would retain the gases, and thus cause their combination under the influence of other bodies in contact with them.

Mr. Crookes has drawn attention to a curious result of the very severe frost experienced at the commencement of this year. Under the combined influence of cold and vibratory motion, large masses of glycerin were noticed to have assumed the solid crystalline state. About five tons of glycerin, in casks of eight cwt. each, were recently imported from Germany, by the firm of Burgoyne, Burbidges, and Squire. When they left the factory the contents were in their usual state of viscid fluidity; but on arriving in London, they were found to have solidified to a solid mass of crystals, so hard that it required a hammer and chisel to break it up.

A large block of this solid glycerin, weighing several hundredweight, suspended in a somewhat warm room, took two or three days to liquify; and a thermometer inserted in the fusing mass indicated a constant temperature of 45° F. In small quantities, the crystals rapidly fuse when the bottle containing them is placed in warm water. In quantity the solid glycerin looks very like a mass of sugar-candy. The isolated crystals are sometims as large as a small pea; they are brilliant, and highly refracting; when rubbed between the fingers they are very hard, and they grate between the teeth. Their form appears to be octahedral.

The crystals, separated as much as possible from the mother liquor, and then fused by heat, form a clear and nearly colourless liquid, slightly more viscid than usual, which possesses all the physical and chemical properties of pure glycerin.

Some of the fused crystals have been exposed for several hours to a temperature of 0° F. without solidification taking place. The only result was that the liquid became more viscid.

The cause of the crystallization is not very clear. The most probable explanation is, that the vibration of the railway journey across Germany, added to the intense cold to which the glycerin was simultaneously subjected, enabled the particles to arrange themselves in a regular form. The phenomenon then becomes analogous to the crystallization of wrought iron under the influence of vibration, and the gradual solidification of syrupy solutions of organic alkaloids.

Mr. Skey, Analyst to the Geological Survey of New Zealand, has discovered the curious fact that if tungstic acid is made red-hot, and then brought in contact with a cold surface, it assumes a black colour, which is permanent in the air. The change in colour here produced appears to be due to the presence of the oxide of tungsten. The effect of a sudden refrigeration of tungstic acid, therefore, is to deoxidize it. If the hot acid is dropped into kerosene oil, the same effects follow.

M. Becquerel, in his name and that of his son, M. Edmund Becquerel, has presented to the French Academy a new series of observations, thermometric and hygrometric, taken simultaneously in free air and under trees, the general results of which may be summed up as follows:—In summer the mean temperature in free air slightly exceeds that under the trees; in winter the contrary is the case. The trees, in spite of their inferior conductibility, very slowly assume a temperature in equilibrium with that of the air. The diurnal maximum takes place towards midnight under the trees, whereas it occurs towards three o'clock in the afternoon in free air. A little more rain falls three kilometres from the wood than at its verge or in the interior. The climate under the trees is therefore a sort of sea-climate, and this conclusion of the thermometric and hygrometric observations is confirmed by numerous facts of vegetation.

The Steam Ice-Machines of M. Toselli, are at present attracting some attention in Paris. An ice-producing machine capable of forming 22 lbs. of ice per hour, or nearly 2 cwts. per day, is a square parallelopiped 9 feet 2 inches long, 6 feet 3 inches wide, and 6 feet 5 inches high. It consumes nearly a halfpennyworth of charcoal for every kilogramme of ice formed, and only requires the attention of one man to set it at work and to give the necessary movement to the circulation of the water The machine costs 180*l*. We believe that the principle on which it is based is the rapid vaporization of a highly volatile liquid, the necessary supply of heat being taken from the water to be frozen.

A somewhat interesting discussion has been going on in the 'Chemical News' for some time past, on the subject of Standard Thermometers. Some of the facts elicited appear not to be known so much as they deserve. It appears that the zero points of all thermometers, as a rule, rise in a month or so after the instruments are made. This rise varies generally between $\frac{1}{2}^{\circ}$ and 2°. The bulbs of the best thermometers should therefore be blown some months before the instruments are pointed. In this manner the greater part of the error may be avoided. Even after all due precautions have been taken, the thermometer should from time to time be either compared with another standard which has been repeatedly checked, or when this cannot be done, its zero should be independently tested by means of melting ice. The use of boiling-water is objectionable for the purpose of testing, as it has a tendency to permanently raise the zero of the instrument, even if it has been unchanged and correct before immersion. The most likely cause of rise is the one-sided pressure of the air. The bulb does not acquire, on cooling, its original size for some months. Every thermometer loses its accuracy, for many months, whenever it has served for the determination of higher temperatures; and there are very few thermometers in use in chemical laboratories that do not come under this head. An instrument, after adjustment, can only once be used for accurate determination of boiling-points without readjustment—a circumstance always lost sight of in chemical researches, and which explains, no doubt, many discrepancies between statements of different authors.

We welcome, with pleasure, a very excellent text-book on the subject of Heat.* A work of this sort has been long wanted for the higher class of schools, and for students at college; and the author, who is Examiner at two of our modern universities, where physical science is directly encouraged, has had ample opportunities of learning the wants of the students of the present day. The book which he has now given to us is concise, without losing in accuracy, or being obscure, and it embraces all subjects that could be included under the question of heat, and treats of the latest developments of the science, as discussed among physicists of the present day. The discussion of perpetual motion, and the connection therewith of the questions of dissipation and conservation of energy, may be mentioned as of especial interest. Throughout the work theories give way to facts, the unknown is grouped markedly from the known, and the methods of practical application of such groupings of facts are fully explained by general formulæ. With this work, Professor Miller's 'Chemical Physics,' Professor

* 'An Elementary Treatise on Heat.' By Balfour Stewart, LL.D., F.R.S. Oxford: Clarendon Press. London: Macmillan & Co.

Tyndall's 'Heat as a Mode of Motion' (and we hope soon to add to these the volumes of Sir William Thompson and Professor Tait on "Natural Philosophy," promised for this series), the student of this year will possess advantages which have never before fallen to the lot of any one whose object is to acquire a thorough knowledge of physics.

ELECTRICITY.—Two very important papers on Electricity were presented to the Royal Society on February 14th. They are on almost the same subject, and are interesting, as showing how the same idea in the minds of two profound electricians becomes developed into an important discovery,—alike as far as the principle is concerned, but widely differing in ultimate results, and in the instrumental means adopted to obtain the desired end.

The first paper was by C. W. Siemens, F.R.S., "On the Conversion of Dynamical into Electrical Force, without the aid of permanent Magnetism." The apparatus employed in this experiment was an electro-magnetic machine consisting of one or more horseshoes of soft iron, surrounded with insulated wire, in the usual manner; of a rotating keeper of soft iron, surrounded also with an insulated wire; and of a commutator connecting the respective coils in the manner of a magneto-electrical machine. If a galvanic battery were connected with this arrangement, rotation of the keeper in a given direction would ensue. If the battery were excluded from the circuit, and rotation imparted to the keeper in the opposite direction to that resulting from the galvanic current, there would be no electrical effect produced, supposing the electro-magnets were absolutely free of magnetism; but by inserting a battery of a single cell in the circuit, a certain magnetic condition would be set up, causing similar electro-magnetic poles to be forcibly severed, alternately, the rotation being contrary in direction to that which would be produced by the exciting current.

Instead of employing a battery to commence the accumulative action of the machine, it sufficed to touch the soft iron bars employed with a permanent magnet, or to dip the former into a position parallel to the magnetic axis of the earth, in order to produce the same phenomenon as before. Practically it was not even necessary to give any external impulse upon restarting the machine, the residuary magnetism of the electro-magnetic arrangements employed being found sufficient for that purpose.

The mechanical arrangement best suited for the production of these currents was that originally proposed by Dr. Werner Siemens in 1857, consisting of a cylindrical keeper, hollowed at two sides, for the reception of insulated wire, wound longitudinally, which was made to rotate between the poles of a series of permanent magnets, which latter were at present replaced by electro-magnets.

On imparting rotation to the armature of such an arrangement, the mechanical resistance was found to increase rapidly, to such an extent that either the driving strap commenced to slip, or the insulated wires constituting the coils were heated to the extent of igniting their insulating silk covering. It was thus shown to be possible to produce, mechanically, the most powerful electrical or calorific effects, without the aid of steel magnets, which latter were open to the practicial objection of losing their permanent magnetism in use.

The reading of this paper was followed by one by Professor Wheatstone, F.R.S., "On the Augmentation of the Power of a Magnet, by the Reaction thereon of Currents induced by the Magnet itself." In this magneto-electric machine the core of the electro-magnet is formed of a plate of soft iron, 15 inches in length, and $\frac{1}{2}$ inch in breadth, bent at the middle of its length into a horseshoe. Round it are coiled, in the direction of its breadth, 640 feet of insulated copper wire, $\frac{1}{12}$th inch in diameter. The armature consists of a rotating cylinder of soft iron, $8\frac{1}{2}$ inches in length, grooved at two opposite sides, so as to allow the wire to be coiled upon it longitudinally; the length of the wire thus coiled is 86 feet, and its diameter is the same as that of the electro-magnetic coil.

If now the wires of the two circuits be so joined as to form a single circuit in which the currents generated, by the armature, after being changed to the same direction, act so as to increase the existing polarity of the electro-magnet, the force required to move the machine will be very great, showing a great increase of magnetic power in the horseshoe; and the existence of an energetic current in the wire is shown by its action on a galvanometer, by its heating four inches of platinum wire ·0067 inch diameter, by its making a powerful electro-magnet, by its decomposing water, and by other tests.

The explanation of these effects is as follows:—The electro-magnet always retains a slight residual magnetism, and is therefore in the condition of a weak permanent magnet. The motion of the armature occasions feeble currents, in alternate directions, in the coils thereof, which, after being reduced to the same direction, pass into the coil of the electro-magnet in such a manner as to increase the magnetism of the iron core; the magnet having thus received an accession of strength, produces in its turn more energetic currents in the coil of the armature, and these alternate actions continue until a maximum is obtained, depending on the rapidity of the motion and the capacity of the electro-magnet.

It is easy to prove that the residual magnetism of the electro-magnet is the determining cause of these powerful effects. For this purpose it is sufficient to pass a current from a voltaic battery,

a magneto-electric machine, or any other rheomotor, into the coil of the electro-magnet, in either direction; and it will invariably be found that the direction of the current, however powerful it may eventually become, is in accordance with the polarity of the magnetism impressed on the iron core.

A very remarkable increase of all the effects is observed when a cross wire is placed so as to divert a great portion of the current from the electro-magnet. The four inches of platinum wire, instead of flashing into redness, and then disappearing, remain permanently ignited. The inductorium, which before gave no spark, now gave one half-an-inch in length. Water is more abundantly decomposed, and all the other effects are similarly increased.

A certain amount of resistance in the cross wire is necessary to produce the maximum effect. If the resistance be too small, the electro-magnet does not acquire sufficient magnetism; and if it be too great, though the magnetism become stronger, the increase of resistance more than counterbalances its effect.

But the effects already described are far inferior to those obtained by causing them to take place in the cross wire itself. With the same application of force, 7 inches of platinum wire were made red hot, and sparks were elicited in the inductorium $2\frac{1}{2}$ inches in length. The force of two men was employed in these, as well as in the other experiments. When the interruptor of the primary coil was fixed, the machine was much easier to move than when it acted; for when the interruptor acted at each moment of interruption, the cross wire being, as it were, removed, the whole of the current passed through the electro-magnet, and consequently a greater amount of magnetic energy was excited, while at the intervals during which the cross wire was complete the current passed mainly through the primary coil.

There is an evident analogy between the augmentation of the power of a weak magnet, by means of an inductive action produced by itself, and that accumulation of power shown in the static electric machines of Holtzman and others, which have recently excited considerable attention, in which a very small quantity of electricity, directly excited, is, by a series of inductive actions, augmented, so as to equal, and even exceed, the effects of the most powerful machines of the ordinary construction.

The magnetic polarity of rifles is a subject to which Mr. Spiller, of the Royal Arsenal, Woolwich, has lately drawn attention. He finds that all the long Enfield barrels in the possession of the volunteers of his company exhibit magnetic polarity, as the result of the violent and repeated concussions attending their discharge, in a direction parallel to the magnetic meridian. The Royal Arsenal range runs nearly north and south, and the rifles, when in

use, are always pointed either due north or a few degrees towards the west; in fact, nearly in the direction indicated by a compass needle,—so that the repeated shocks brought about by the explosion of the powder may be considered equivalent to so many hard blows from a hammer, which are known to have a similar effect. The magnetic character appears to be permanent, which would not be the case if the gunbarrels were of the softest description of malleable iron; and the region of the breech is, in every instance, possessed of north polarity, since it strongly attracts the south pole of the compass needle. These effects would probably not be noticed at all, or only to an inferior degree, in arms ordinarily fired, in directions east and west; and it would be imagined that by reversing the usual practice, if it were possible, and firing towards the south, the indications of polarity would be changed.

The foregoing observation seems to have a parallel in the remarkable instance of the polarity of Her Majesty's ironclad 'Northumberland,' built last year at Millwall. This vessel was placed due north and south during her construction, and the repeated vibrations to which she was subject whilst in that position induced a condition of polarity which demanded a subsequent operation for the purpose of demagnetizing her. No such practical inconvenience arose in the case of the iron steamship 'Great Eastern,' which was built in the same yard, but in a position at right angles to the former, or nearly due east and west.

M. Roullion proposes a new battery based upon some observations he has made on the action of aqua regia on silver. A mixture consisting of two-thirds hydrochloric and one-third nitric, or three-fifths hydrochloric and two-fifths nitric acids will easily dissolve gold and platinum, but will only superficially attack pure unalloyed silver; a superficial chloride being formed, which protects the rest of the silver like an impermeable varnish, however long it may remain in the aqua regia. If copper be present, the metal is attacked. M. Roullion has utilized this fact to make a new battery, in which pure silver in aqua regia replaces the platinum or carbon in the nitric acid of a Grove's or Bunsen's cell. He says that after several months' use, the silver has not sensibly diminished in volume, and no chloride of silver has been found in the porous cell. He considers this battery to be more constant than Bunsen's battery.

The gas battery of Mr. Grove has received some attention from M. J. M. Gougoin. He arrives at conclusions in perfect conformity with those of M. Schönbein. Mr. Grove supposes that it is indispensable for each of the electrodes of platinum of his gas-couple to be simultaneously in contact with one of the gases and with the liquid placed underneath. M Gougoin states, on the con-

trary, that the action of the platinum does not take place except on the gases already below, and that the gas receivers should only be considered as reservoirs to maintain in a state of saturation the solutions they cover. The electro-motive force of the gas-couple varies curiously with the state of the platinum wire. Its action is increased, as M. Matteucci remarked, by heating the elements in the flame of a spirit-lamp some instants before employing it. In the most favourable conditions, the electro-motive force of the gas-couple constructed with platinum wires not platinized scarcely exceeds 155, taking as unity the electro-motive force of a thermo-electric couple of bismuth and copper, the two solderings of which are maintained at the temperature of 0° and 100° C. The electro-motive force of a Daniell's couple is represented by 193, and that of Volta by 178, at the moment of being set to work.

An automatic electro-chemical method of electric transmission of despatches has been invented by MM. J. Vavin and G. Fribourg. It consists in the distribution of the current through as many short and isolated small wires as there are signals to be transmitted, whilst employing only one wire on the main line. Each of these small isolated wires communicates on the one hand with a metallic plate of a particular form fixed in gutta-percha, and on the other hand with a metallic division of a disc, which is equally formed of an insulating substance. A group of eleven of these small laminæ form a sort of character which will give all the letters of the alphabet by the suppression of certain portions of the fundamental form. Now, supposing rows of these compound characters to be placed on a sheet of prepared paper of a metallic nature, the words of the telegram to be sent are written on them with isolating ink, leaving the other parts of the small "stereotyped" blocks untouched. The consequence is that the current is intercepted at every point touched by the ink, and a letter is imprinted on the prepared paper at the other end of the line where the telegram is to be received. The process by which all these several currents are sent along the one main wire and then made to separate at the end and pass into their respective small wires, is not at all clear in the authors' description.

Lightning-protectors for telegraphic lines have been in use for many years; an improvement lately brought out consists of two smooth brass plates from 3·87 to 4·65 square inches, placed one above the other, and separated by a sheet of paper; one of the metal plates is in connection with the line, the other communicates with the earth. As soon as a rather strong tension occurs on the line, sparks pass from one plate to the other, perforating the paper, and the electricity passes into the earth instead of along the line, disarranging the instruments. M. Guillemin proposes to

replace the paper by a very thin layer of mica. The mica is a better insulator; it does not absorb damp; it cannot produce carbon, since it is of a mineral character; moreover, its ready cleavage allows of its being split into plates thinner than a sheet of paper. The administration of the French telegraphic lines purposes placing very shortly a great number of these lightning protectors in places subject to most frequent attack by the electric fluid of the atmosphere.

The lecture theatre of the Royal Institution was crowded on Friday evening, the 15th of February, to hear a discourse, by Mr. Cromwell Varley, "On the Atlantic Telegraph." On the table there were displayed coils of the cable successfully laid last year, and of the cable which had been picked up from a depth of two miles, having lain at the bottom of the sea for twelve months. Mr. Varley did not enter into the consideration of the mechanical construction of the cable, nor of the plan of laying it down, but confined himself to the scientific part of the subject, and to the explanation of the difficulties which arise in attempting to transmit electric signals through great lengths of submerged insulated wire. By means of his artificial cables he demonstrated, for the first time in public, how the electric waves travel through. He also showed what were the limits imposed by nature to rapid signalling.

A telegraphic cable is a long Leyden jar, one end of which is attached to the earth, whilst the other is attached to a source of electricity each time a signal is to be produced. If the cable be connected to a battery for a long time, the strength of the charge in the different parts of the cable will be nothing at the end next the earth, and equal to the full power of the battery at the other end.

The lecturer had diagrams showing the rate at which the strength of the electric currents augmented or died away at the distant end of the cable, when a battery was applied or removed from the other end. From these diagrams and experiments it was shown that to get rapid signals the receiving instrument must be very sensitive, and the moment a current begins to appear at the distant end the rest of the electric wave must be neutralized, to permit a second signal to follow. This was illustrated by an artificial line equal to a cable 13,000 miles long. This line was divided into eleven sections, and ten reflecting galvanometers were inserted at equal distances along it. To familiarize the audience with the relative position of the galvanometers, Mr. Varley called No. 1, Gibraltar; No. 2, Malta; 3, Suez; 4, Aden; 5, Bombay; 6, Calcutta; 7, Rangoon; 8, Singapore; 9, Java; and 10, Australia.

A long telegraphic cable is a long Leyden jar of great resistance—so great that, instead of electrical charges rushing in and out almost instantaneously, as is the case with ordinary Leyden jars, an appreciable time is necessary to convey a decided charge through so long a conductor to the distant end. The artificial representative consisted of eleven resistances and ten immense condensers, or Leyden jars, connected between the resistances and the earth. By moving a handle the condenser could be applied on or removed from, these junctions.

On depressing an ordinary commutation key, the cable was removed from its connection with the earth, and a positive current allowed to flow into the line. On depressing a second key, a negative current rushed in; whilst when both the keys were at rest, the cable was simply connected with the earth. The ten reflecting galvanometers were placed one above the other, and a bundle of rays from the electric lamp was thrown upon the ten mirrors, each of which reflected a little sun-like spot upon a large white screen, forming, when no current was passing through the cable, a straight vertical line of luminous points. On pressing the right-hand or positive key, the upper spot, which was named Gibraltar, almost immediately responded; and when it had travelled about thirteen inches over the screen, the second spot, Malta, began visibly to move; the third spot, Suez, following later still. It was, however, fifteen or sixteen seconds before any decided motion or current was noticed at the Australian end of the line. After the lapse of a minute, a powerful current was rushing out at the Australian end. The English end was then removed from the battery and connected with the earth, and quickly after the Gibraltar spot rushed across to the other side of the screen, indicating the rushing back of a powerful current to the earth. This was followed shortly afterwards by Malta, Suez, and Aden. Bombay came only as far as the zero line. The currents in the different parts of the cable were flowing out at each end, leaving Bombay neutral. It was some minutes before the cable discharged itself sufficiently to allow the ten spots to come near enough to the zero line to admit of a second experiment.

In 1863–64 Mr. Varley found, by experiments on his artificial line, that by using a succession of four or five currents, all of the same strength but varying in direction, greater rapidity could be secured. For example:—First, a positive current, followed by a negative of longer duration; followed again by a positive current of much less duration; then a shorter negative current; and that again by a very short positive current, produced a succession of positive and negative waves throughout the line: the result of all of which was at the Australian end one very small positive wave

perfectly distinct, the rest of the line being left almost immediately entirely free from all traces of electricity, ready for the instant production of a second signal.

This operation of discharging has been expedited to such an extent by means of the instrument known as the "curb key," that the great wave can be arrested at the distant end of the cable before it has arrived at $\frac{1}{100}$ of its proper height, and the line left clear for another signal almost immediately after. This was illustrated by the Australian line.

The lecturer then showed his invention for preventing the disturbance arising from earth-currents, and for expediting the signals through the cable, which did not record the strength of the current, but "the rate of increment and decrement of potential."

He placed a reflecting galvanometer between the distant, or "Newfoundland," end of the cable and the earth (this being the usual mode of connecting telegraph instruments), and also a second one with a "condenser" between it and the earth. At the English end there was an apparatus which produced currents through the cable similar to those produced on the telegraph circuits by the Aurora Borealis and other causes. These experiments were very conclusive; the slow but large wave of the earth-current was seen to produce scarcely any action upon the galvanometer with the condenser, while the ordinary one was seen running 20 feet on either side of the scale in consequence of the earth-currents.

The small waves on the back of the great swell of the earth-currents were, however, perfectly disentangled, by this simple contrivance, from the great slow-rising wave, and the signals were perfectly legible on the one instrument, while illegible on the other, whose image ran wildly over the wall of the Institution. In addition, the signals were transmitted more rapidly and clearly by this arrangement.

In concluding, Mr. Varley remarked that it was upon the data furnished by this artificial cable that he had designed the present Atlantic cable, and that without it he could not then have guaranteed eight words a minute without a core whose conductor and insulator were each 60 per cent. greater than the present, which consisted of 300 lbs. of copper and 400 lbs. of gutta-percha to the mile; and he added that it was at least some reward for the years of arduous labour he had had in connection with this great enterprise, to find that everything he had predicted as to the capabilities of the cables had been entirely verified.

12. ZOOLOGY, ANIMAL MORPHOLOGY, AND PHYSIOLOGY.

Morphology.—*The Structure of the Retina.*—That eminent observer, Professor Max Schultze, has recently published in his 'Archiv f. Mikroskop f. Anatomie,' a memoir on the Retina, which occupies more than 100 pages, and is illustrated with eight quarto plates, forming by far the most complete and clear exposition of the structure of this organ which has yet been published. Amongst the important new facts adduced by Professor Schultze is the observation that in Mammalia a very remarkable, and, as it would seem, hitherto unnoticed diversity, exists, with regard to the distribution of "rods" and "cones." Whilst most of our larger domestic animals, especially the sheep, ox, pig, horse, and dog, present an arrangement of those elements resembling that which is observed in the human subject and in apes (except, of course, in the absence of the *macula lutea*), the cones, according to the author's observations, are entirely wanting in bats, the hedgehog, mole, mouse, and guinea-pig. A sort of intermediate condition is met with in the cat, rabbit, and rat, in which animals are found either very slender true "cones," as in the cat, or merely indications of them, as in the rabbit. The development of the retina and the probable functions of the rods and cones are fully discussed. The great value of Professor Schultze's paper lies in the fact that he has not only made many new observations, but has most carefully tested the conclusions and statements of previous writers; and further, has spared no pains in illustrating his text with some of the most beautiful lithographs yet published. In his researches Professor Schultze has experienced the greatest advantage from the use of a solution of hyperosmic acid, $Os\,O_4$, which colours nerve-tissue black, without producing much effect on connective and fibrous tissue. We most strongly urge upon microscopists the importance of making further trial of so valuable a reagent.

Entozoa of Man and Domestic Animals in Iceland.—M. H. Krabbe has made some valuable investigations on this matter, in pursuance of a commission from the Danish Government. He has ascertained various important facts with regard to the distribution of species of *Tænia*, *Bothriocephalus*, &c., and has observed some new forms. He is quite convinced that the frequency of *T. marginata*, *cænurus*, and *echinococcus* in Iceland is owing to the very vast number of sheep which the inhabitants possess, and the large number of dogs which they use in herding them. It appears that in Iceland there are for every hundred of inhabitants *four times* the number of cattle which there is for every hundred

inhabitants in Prussia. At the same time he maintains that the frequency of the fearful malady caused by *echinococcus* is much exaggerated—instead of one-seventh, only one-fiftieth of the population is affected, which is quite terrible enough.

Physiology.—*Impregnation of the Ovum* versus *Nourishment of the Larva.*—Dr. Herman Landois has recently communicated some important observations on this subject to the French Academy. It is generally believed, in accordance with the observations of MM. Dziergon and von Siebold, that the worker-bees are born from eggs fecundated by the queen by means of the sperm of her receptaculum seminis, whilst drone-bees come from non-fecundated eggs. M. von Siebold maintained, in particular, that the demonstrated existence of spermatozooids in the eggs contained in the "cells" appropriated to worker-bees, and their non-existence in the eggs of drone-cells, sufficiently proves that in bees the formation of the sexes depends upon fecundation. It is, however, well known that the "cells" of drone-bees are not in any way identical with those from which "worker-bees" emerge, and that the food provided for the larvæ of the one is not the same as for the larvæ of the other. This led Dr. Landois to speculate as to whether it might not be possible, by placing the egg from the drone-cell into the worker-cell, and *vice versâ*, to produce drones from the worker-eggs and workers from the drone-eggs. This he accordingly tried with great care, failing at first on account of the exceeding delicacy of the eggs experimented on, but finally meeting with most complete success. By simply changing the "cell" of an egg, he produced a drone or a worker-bee at pleasure. These observations have a most important bearing on the law of sexual development, not only in insects, but all animals. We had been taught to believe, from Siebold's experiments, that the "network of causes" was so arranged that a queen-bee, if unimpregnated (as might result from paucity of drones), produced from her eggs nothing but drones, in order that the next generation might not be wanting in that "vigour" which is supposed to be the final cause of sexual reproduction. If, however, Dr. Landois' experiments are true, this view must be considerably modified, for the nutrition of the larval animal is shown to regulate the phenomenon. Dr. Landois has entered into some philosophical generalizations on reproduction in the conclusion of his paper, which is not, however, yet published in full.

Action of Nitrous Oxide on the Human System.—It appears that the protoxide of nitrogen has been used in Germany and France as a means of producing anæsthesia in surgical operations. M. L. Hermann addresses a letter to the French Academy on the subject, seriously urging all operators to make themselves acquainted

with its properties before using it as an anæsthetic. He has made several experiments with it himself, and has found that, when respired in a pure condition, protoxide of nitrogen is dangerous; for, besides loss of sensibility, asphyxia is produced, which may kill the patient; administered in a state of mixture with oxygen, the only plan which, in M. Hermann's opinion, would not be simply criminal on the part of the operator, it constitutes a very feeble anæsthetic, from which recovery is rapid. Its use has already produced most serious disasters in Germany.

The Wave-lengths of the Transmission of Muscular and Nervous Action.—In a late Chronicle we noticed Dr. Marey's instrument, the Myograph, with which he has been able to make observations on the *muscular susurrus*—that is, the separate vibrations which, when succeeding each other sufficiently rapidly, constitute a muscular contraction. Dr. Haughton, of Dublin, has been comparing the rate of these vibrations, and their lengths, with those caused by nerve action. Wollaston fixed the muscular susurrus, or agitation sufficient to produce contraction, at from 20 to 30 per second; Dr. Collongues, of Paris, at 35; and Dr. Haughton, as also Helmholtz, at 32 in a second. Dr. Haughton, from the so-called *tinnitus aurium*, which is caused by the action of the nerves, fixes the rate of nerve vibration at 1,024 in a second. From these data it follows that the rate of nerve action is from 29 to 32 times as fast as the rate of muscular action. Dr. Schelske's experiments have shown that the velocity of wave-transmission of sensation in the living body of man is 97 feet per second; and the experiments of Professor Aebe, of Berne, show that the velocity of wave-transmission of muscular contraction in frogs is 3 feet per second. The wave-transmission in nerves is therefore 32 times as fast (or 29 times, if Helmholtz's determination of 88 feet per second be taken) as the wave-transmission in muscles. It appears, from these facts taken together, that the velocity of the wave varies inversely as the rate of vibration when muscles and nerves are compared, and consequently the length of the wave is constant: hence the wave-length of muscular and nervous action, for both lies between 1·125 and 1·225 inch. Dr. Haughton considers that important consequences ought to follow from this deduction, if true. Many advantages may flow from identity in wave-length of the muscular and nervous force, and the consequent identity of nodes, notwithstanding the very different velocities with which wave-pulses are propagated along them. The data upon which these calculations are made admit, of course, of great extension. Since, as Dr. Marey has shown, the muscular susurrus in the frog may be only 4 per second, and in some birds 75 per second, it would be as well that all the data should be taken from one animal or class of animals, if the calculation

is to be a sound one. It is an assumption, the truth of which ought to be proven, that the rate of transmission of muscular force is the same in all animals.

The Origin of Muscular Power.—The view held by Liebig, and till lately implicitly received as true, that muscular power is due to muscle-oxidation, has been, during the last few months, rudely shaken. Professors Fick and Wislicenus, in an ascent of the Faulhorn in Switzerland, found that the amount of measured work performed in the ascent exceeded by more than three-fourths the amount which it would be theoretically possible to realize from the maximum amount of muscle-oxidation, indicated by the total quantity of nitrogen in the urine. These two observers had, however, to content themselves with the *theoretically* possible force, and hence there was an experimental gap in their reasoning. This has been supplied by Professor Frankland; he has made an extensive series of experiments on the oxidation of muscle and urea in oxygen, and has made a calorimetrical determination of the actual energy evolved by the combustion of these bodies. His experiments are recorded in full in a late number of the 'Philosophical Magazine,' and the various steps of the very intricate process through which he has successfully carried his observations fully described. Since the oxidation of muscle-tissue in the body has, as one of its products, urea, it is necessary to make allowance for the potential energy of this urea in applying the results of the complete oxidation of muscular tissue to the question at issue. It is also necessary to make allowance for the fact that *all* the energy developed in the body cannot be made to appear as *external* work. Helmholtz estimates that not more than one-fifth of the actual energy developed can be made to appear as external work; while Heidenhain, under favourable circumstances, allows one-half. Taking this last estimate, Dr. Frankland finds that only one-fifth of the work done by the two professors could be accounted for by the oxidation of their muscular tissue, as indicated by the urine. He further reviews the results of Dr. E. Smith's, Dr. Haughton's, and Dr. Playfair's experiments, applying his determination of the "mechanical equivalent" of muscle-oxidation to their results.

The work done in the body is then evidently due merely to the oxidation of the food held in the blood. The chief use of nitrogenous food is to build up muscle-tissue, which, like the cylinder and piston of the steam-engine, does not contribute to the work performed by its oxidation, but is the means of converting chemical and thermal modes of force into motion; the force being really obtained by the oxidation of principally carbonaceous, but to some extent also nitrogenous, foods contained in the blood.

The Value of Nitrogenous and Carbonaceous Foods.—This question, which is one obviously resulting from the conclusions ar-

rived at by Fick and Wislicenus, has been examined experimentally by Professor Pettenkoffer, and more recently also by Dr. Parkes. Professor Frankland has also determined the mechanical value of these forms of food, by experiments on their oxidation. Professors Fick and Wislicenus ate carbonaceous, but no nitrogenous food during their ascent, and hence concluded that all the power not derived from muscle-oxidation was due to the oxidation of the carbonaceous foods. Pettenkoffer's experiments, which are most conclusive as regards the whole question of the source of muscular force, were made by means of a most elaborately constructed chamber, in which a man was placed, and all his excreta, gaseous, liquid, and solid, examined. Dr. Parkes experimented very carefully on two soldiers at Netley Hospital, and communicated his results to the Royal Society at the beginning of this year. Both these observers have fully established that mere force *can* be supplied by carbonaceous food alone—that nitrogenous food is necessary to build up the worn muscles, and that nitrogenous food, by its *direct* oxidation, is also efficient in supplying force, and perhaps presents certain advantages over carbonaceous food in its use, either from the facility of its oxidation, or by a catalytic action on the carbonaceous foods with which it is generally taken. The views we have been briefly noticing are of too great importance to admit of their due appreciation from the perusal of so few lines, and we must therefore refer the reader to the original memoirs in which they are advanced. It should be mentioned that Voit, a chemist of Munich, appears to have anticipated these results by some few years; his speculations were, however, cast into obscurity by the proximity of the over-shadowing genius whose assertions they controverted.

Miscellaneous.—Dr. Ernst Haeckel has just published two very remarkable volumes on the philosophy of organic forms, entitled 'The Morphology of Organisms.' He takes much the same line of argument as Mr. Herbert Spencer in his 'Principles of Biology;' but he enters into greater detail, and develops his views further than the English writer. This book, like that of Mr. Spencer, may be regarded as an extension of Mr. Darwin's generalizations, and is, as far as we have been able to observe, a work destined to exert considerable influence in the world of physio-philosophers. We have also to notice a little *brochure* on 'Spontaneous Generation and the Development of Infusorial Life,' forwarded to us by Mr. Jabez Hogg. The author has told the story of Heterogenesis (which, by the way, is getting rather old) in a clear and plain manner, drawing attention more particularly to the question of the successive appearance of forms of Infusoria in an infusion, as studied by Mr. Samuelson, Balbiani, and others. There are one or two inaccuracies in nomenclature, such as *Acitena; Vor-*

ticellæ are confused with *Rotifers*, &c., and a misapprehension is evident of recent observations on the refractive power of fungus-spores, as seen in the "blue-mist;" these errors would be serious in a scientific publication, but do not really affect the value of a popular essay.

Proceedings of the Zoological Society.

At the meetings of this session there have been numerous valuable papers read, chiefly devoted to the description of new forms or rearrangement of previously known animals. The following papers relate to the Mammalia:—Mr. W. H. Flower, F.R.S., has brought forward a memoir on the skeleton of *Inia Geoffroyensis*, and on the skull of *Pontoporia Blainvillii*, in which he made some remarks on the systematic position of these animals in the order Cetacea. Mr. Flower has recently been devoting much time and attention to the study of this order of mammals, as his work published last year by the Ray Society testifies. Dr. W. Peters, of Berlin, made a communication on some Mammalia collected by Captain Bevan in Bermuda, and on a collection of bats from Trinidad. Mr. Gerard Krefft, of Sydney, has described two new species of Dasyuridæ, which he proposes to call *Podabrus Michelli* and *Chætocercus cristicauda*. Mr. Robert Swinhoe, H.M. consul at Amoy, China, has forwarded a new monkey to the menagerie, which he proposes to call *Inuus Sanctijohannis*. Mr. St. George Mivart, in continuance of his researches on the Primates, has communicated a paper on the appendicular skeleton of the Ourang-Outang, in which he has entered very minutely into the osseous characters of that animal.

Mr. P. L. Sclater described a new species of Ratel, recently added to the Society's menagerie, which he proposed to call *Mellivora leuconota*. A letter has been received from Mr. E. Bartlett, now engaged in exploring the fauna of Peru, in which he mentions the discovery of a remarkable species of spider-monkey, supposed to be new to science. The death of the sea-bear (*Otaria*) has afforded an opportunity for the examination and dissection of its viscera, which we believe has never yet been possible. The Society's Prosector, Dr. J. Murie, has been occupied in this task, and some important results may be expected from his investigations.

In Birds, we have numerous new species, or rarer forms, described by Mr. Sclater, and other ornithologists. Dr. Murie has been making some investigations with regard to the *Cygnus buccinator*, and the new *Cygnus Passmori* of Professor Hincks, which he considers to be nothing more than a variety of the former.

Dr. Gray and Dr. Günther have described a few new reptiles. The former characterizes a Geckoid lizard from Ceylon, which he proposes to call *Gecconella punctata*.

The Fishes of Central America, among which are some very remarkable forms, and various new fishes in the British Museum, have formed the subjects of communications from Dr. Günther.

Mr. A. G. Butler, who is the rising Lepidopterist of the day, has described several new forms of these insects at various meetings of the Society, illustrated by most finished drawings from his own pencil. One of his most complete papers is entitled "A Monograph of the Genus *Euptychia*, a numerous race of Butterflies belonging to the family Satyridæ, with Descriptions of Sixty Species new to Science, and Notes on their Affinities." The Coleoptera of the island of Penang have formed the subject of communications from Mr. F. Pascoe, while Mr. F. Moore has contributed a monograph on the Lepidoptera of Bengal.

The Mollusca collected by Mr. E. Bartlett on the Upper Amazons and in Eastern Peru, have been described by Mr. Henry Adams. The genus Opisthostoma, of which a new species has been discovered at Bombay, has been discussed by Mr. Blandford; and several new Australian land-shells have been described by Dr. J. Cox; and thirty-two new marine species of Mollusca from the same part of the world have been described by Mr. Angus.

The extraordinary Glass-Rope animal has been the subject of great controversy between Dr. J. E. Gray and Dr. Bowerbank, the former maintaining that it is a coral, the latter that it is a sponge. It appears that there are three views current with regard to this marine organism. It is regarded as a coral, having a sponge parasitic upon it; or as a sponge, having a coral parasitic upon it; or as altogether a sponge, there being no parasite in the case. Dr. Gray is of the first opinion, Professor Max Schultze of the second, and Dr. Bowerbank of the third. Dr. Bowerbank's position is clearly untenable, and the question really lies between the views of Dr. Gray and Professor Schultze. Dr. Gray has described and exhibited a specimen which was said to come from the coast of Portugal, the other known specimens all being obtained from Japan. It appears very doubtful as to whether this Lusitanian Hyalonema is not an imposition played off by the sailor who said that he dredged it up; this is the view taken by Professor Schultze, but Dr. Gray believes firmly in the species.

THE PUBLIC HEALTH.

During the past three months the public has had an opportunity of seeing what can be done by the "Sanitary Act of 1866." Powers are there given to local bodies to act with much more energy than under any previous sanitary enactment, but as yet little benefit has been recorded as the result of these powers. The "permissive" character of all our previous legislation is still the bane of this Act, and our local authorities turn a deaf ear to the allurements presented by the government. If all our criminal legislation were put upon the permissive basis, there is little doubt that in some parishes the vestries would not take the trouble to prosecute those who were guilty of the crime of murder. This Act nowhere says it shall be unlawful for a man to keep his house and premises in such a state that he may kill his neighbours, but it gives to the local authorities power, if they think fit, so to prosecute and punish him. The mischief is the local authorities do not punish, nor act even, if they see a man poisoning and killing his neighbours by his dirty and filthy economy. This Act gives the Home Secretary power to compel vestries to act upon cases where manifest evils result from allowing nuisances injurious to health to exist, but the Home Secretary is as chary as a vestryman about taking action in particular cases, and from this cause at present little has been done.

The 35th clause of this Act has, however, excited some attention, and in London, Liverpool, and other towns there has been some discussion as to how it may be carried out. This clause gives power to the vestries and local boards to frame regulations for the conduct of all houses let out in lodgings, or where more than one family is residing and paying rent to a common landlord. This provision is intended to meet the necessity of a large proportion of the population of our large towns, who are merely lodgers and have no power of providing against various nuisances injurious to health, for which alone the landlord is responsible. Under the provisions of this Act, the nuisance authority is empowered to make regulations for the following matters, that is to say:—1. For fixing the number of persons who may occupy a house or part of a house which is let in lodgings or occupied by mechanics of more than one family. 2. For the registration of houses thus let or occupied in lodgings. 3. For the inspection of such houses and the keeping the same in a cleanly or wholesome state. 4. For enforcing therein the provision of privy accommodation and other appliances and means of cleanliness in proportion to the number of lodgers and occupiers, and

the cleaning and ventilation of the common passages and staircases. 5. For the cleaning and lime-whiting at stated times of such passages, &c.

This clause gives power to vestries to take into their own hands the redress of sanitary grievances. Manifold and obvious as are the nuisances to be thus got rid of, it is astonishing with what indifference this Act has been regarded. In the metropolis the first parish to take advantage of the law was that of St. Giles, and a series of excellent regulations, framed upon the recommendations of the Privy Council as to the carrying out of the above clause, were drawn up by their intelligent medical officer of health, Dr. Buchanan, and received the sanction of the Home Secretary. The publication of these regulations was followed by applications from the vestries of Chelsea and Poplar, who have also had their regulations confirmed by the Home Secretary. The parish of St. James, Westminster, has also made application for the confirmation by the Home Secretary of a series of regulations. The latter parish was anxious to obtain power to regulate the accommodation afforded by the numerous establishments in that parish for milliners, tailors, apprentices, and others. The officers of the Privy Council, however, were of opinion that the clauses of the Sanitary Act did not refer to persons thus situated. This is much to be regretted, as it is very evident from what has transpired that persons employed in the large establishments of London are obliged to submit to accommodation in workshops and sleeping-rooms totally unfitted to secure health and life. In the parish of St. James, Westminster, the great mortality from consumption is one of the most conspicuous features of its death returns, and there can be little doubt that this arises from the defective accommodation provided for a large portion of its population.

One of the most conspicuous features of the above regulations is the attempt to define the quantity of cubical space that shall be required in the lodging-rooms of the metropolitan population. In St. Giles's, a space of not less than 400 cubic feet is required for each person. In Chelsea, the minimum space for a room used for both living and sleeping is 350 cubic feet, and for sleeping alone is 300 cubic feet. In Poplar, the space required for both living and sleeping is 400 cubic feet, and 300 for sleeping alone. In these cases two children under ten years of age count as one adult, and should these regulations thus sanctioned by the State be carried out with vigour, there is no doubt of the benefit that must accrue. But when it is seen that only four out of the fifty districts, into which London is divided for sanitary purposes, are willing to adopt these necessary regulations, it is much to be feared that the same neglect of the health and lives of the community which have hitherto characterized London vestries will still continue. It is

little creditable to the large and wealthy communities of St. Marylebone, Paddington, St. Pancras, Islington, and the parishes of the East of London generally, that they have not stirred in this matter more vigorously.

The clauses 27 and 28 of the Sanitary Act have already been acted on in London with great benefit. By these clauses the medical officer of health is enabled to remove a dead body, where it lies in the midst of the living, to the parish dead-house previous to interment. The coroner has also the same power to order the removal of bodies to convenient places for the purpose of post-mortem examinations. In Central Middlesex this plan has now been carried out in many instances, and has met with little or no opposition from the relatives of the dead, and hence the saving of much inconvenience to the medical witnesses and of time to the juries. The same clauses of the Sanitary Act, 1866, give power to the vestries to build mortuaries, or dead-houses, for the reception of the dead. If these places were built independent of the work-house, and fitted up with regard to the solemn feelings inspired by death, and made architecturally pleasing to the eye, there is little doubt that large numbers even of the wealthier classes would have recourse to them for the purpose of depositing their dead before burial. Such places should be sufficiently large to receive all the dead of the district in which they exist, and should have a room attached for post-mortem examinations, and another larger room in which the coroner and his jury might assemble. The place should be taken care of by persons who should keep everything scrupulously clean, and disinfectants should be applied to the dead bodies in all cases where the slightest effluvium is emitted. Such places might easily be erected on the shut-up burial-grounds throughout London, and would be alike beneficial to public health and creditable to our civilization.

The prospects of Sanitary Legislation for 1867 are almost entirely confined to the passing of the Metropolitan Poor Act of 1867. The progress, however, of this Bill has been so satisfactory that there is now every reason to hope that it will speedily become law. It has long been apparent that the present constitution of our workhouses and their management by the Guardians of the Poor, however desirous the latter might be of doing their duty by the poor, were open to great scandal. The principal object of the Guardians was to keep down the expenditure of the rates, and as long as this object was attained they cared little for the welfare of the poor. Although subject to the control of the Poor Law Board, that body has always been kept at arm's length by the Guardians, and it was only the investigations of the coroner's court penetrating the interior of the workhouses in London, that at last brought to light the mismanagement and neglect that

characterized the arrangements in metropolitan workhouses. The object of Mr. Gathorne Hardy's Metropolitan Poor Bill is to take out of the hands of the present Boards of Guardians the management of the sick, infirm, aged, and insane poor, and place them in institutions under the control of managers, partly appointed by the parishes and partly by the Poor Law Board. London, for the purposes of this Act, is to be divided into districts, in which asylums will be built, having for their especial object the treatment of the sick and insane and the care of the infirm. Dispensaries for the poor are to be erected, where those unable to pay for medical attendance will have a claim for assistance, and other arrangements are to be made which will go far to redeem the character we have lost as a nation for the care and regard of our suffering classes.

The obstruction to business and the danger to life from the overgrown traffic in some of the larger streets of the metropolis, have at last excited the attention of our legislature. Nothing could more forcibly demonstrate the weakness and imperfection of the municipal institutions of London than their utter incapacity to deal with this increasing and universally acknowledged nuisance of the overcrowding of our street traffic. Upwards of two hundred persons have been killed every year for the last five years in the streets of the metropolis, and it has been shown where one person is killed forty are injured, and receive hospital relief.* A large amount of this death and suffering might be prevented by proper legislation, and a Bill has been presented to the House of Lords by the Earl of Belmore for the purpose of procuring legislation on this subject. The principal provision of this Bill is the prohibition of scavenging and the removal of refuse between the hours of ten in the morning and seven in the evening; also, the prohibiting of the unloading and loading of coal, casks, timber, and other heavy goods during the hours of the day. There are also provisions for the removal of snow, and regulations with regard to dogs in order to prevent the extension of hydrophobia. The Bill, as printed, has received considerable alteration in the House of Lords, but still it is to be hoped that a measure will be passed this session of Parliament that will ensure a diminution in the future of the danger which in a single year makes the streets of London more destructive than a great battle.

Although no public action will be taken by the Government on the subject of Water Supply during this session of Parliament, this question must increasingly demand the attention of our legislators. However ample the supply to London may be from the Thames at the present moment, all parties admit that *it is a contaminated supply, is always dirty, sometimes dangerous, and soon must be deficient.* A royal commission, with the Duke of Richmond in

* See 'Third Annual Report of the Coroner for Central Middlesex.'

the chair, and consisting of Sir John Thwaites, the late Lord Mayor of London, Colonel Harness, and Mr. Prestwich, are now sitting, and examining witnesses on the question of the general supply of water to London. Besides the Thames, there are only two other sources of water for London: water from the chalk, or water from the lakes of Wales and Cumberland. The Corporations of Liverpool and of other towns have placed themselves in relation with the Royal Commission to obtain supplies for their respective towns.

At a recent meeting (February 1st, 1867) of the Social Science Association in London, Mr. Bateman read a paper "On a Constant Supply of Water for London," and showed, instead of the present intermittent supply involving the storing in leaden cisterns, that London might have a constant supply without any increase of consumption.

Mr. Thomas Beggs read a paper "On the Water Supply of London," at the Society of Arts on the 22nd of February, 1867. He took a survey of the various plans for affording a further supply of water to London, and defended the present supply from the Thames from the charges brought against it. An interesting discussion followed, in which the whole question of water supply was looked at from various points of view.

Mr. J. B. Denton has published a pamphlet on the question of a water-supply to London, which will probably be noticed in our next Number.

The Social Science Association has had other interesting sanitary questions brought before it during its present session. A most interesting paper was read "On the Social Condition of Merchant Seamen," by Captain Henry Toynbee. He suggested several practical improvements in the treatment of our seamen, and especially pointed out the increase of disease from the neglect of proper diet and accommodation. It is one of the great disgraces of our Mercantile Marine, that life on board their ships is more hazardous to the sailor than living in the most densely populated and ill-ventilated courts of our great cities. It is high time that the shipowners of London, Liverpool, Hull, and Glasgow should see into these things, and wipe this great disgrace from the nation that is never weary of singing till she is hoarse that she "rules the waves." If she would set a better example of how to do it, other nations might listen to the song with more patience.

The result of Captain Toynbee's paper has been the formation of a "Society for the Improvement of Merchant Seamen." We strongly recommend this society to all interested in ships. Its rules, if carried out, will improve the health, strength, and morals of our merchant seamen, render shipwrecks less frequent, and the profits of our mercantile marine much larger.

The department of Public Health of the Social Science Association are about to submit to the President of the Privy Council a memorial on the Public Health Laws, pointing out their diversity and complexity, and consequent feebleness and inactivity. In the conclusion of their memorial to the Government they state—

"1. That the laws of public health require to be revised and consolidated with plain and specific enactments on all sanitary matters.

"2. That permissive enactments are generally taken to be permissions not to act, and that the most useful provisions should be made peremptory.

"3. That the very common deficiency in the administration of the health laws by the local authorities is due to the absence of a central power, which could be appealed to without reference to the courts of law, and could by means of the law compel the local authorities to do their duty."

The permissive character of all our sanitary legislation has long been seen to be the bane of our national existence and the source of a mortality in all our large towns at once alarming and disgraceful. The necessity of bringing the force of public opinion, if not the power of the state, to bear upon our local authorities, who persistently refuse to act upon the powers given them, has led to the formation of a Sanitary Reform League. This body, which held its first meeting at Manchester in February last, already numbers amongst its members many gentlemen in London, Manchester, Liverpool, Leeds, and other towns. It is intended shortly to hold a conference in London, and it is hoped that a body of earnest workers for the welfare of their country will thus be brought together, who will compel an unwilling legislature, and the yet more unwilling vestries of this country, to adopt those measures which are every day becoming more pressingly necessary for the saving of the lives of the people of this country.

As a proof of the necessity of active measures being taken at once, we would refer to a paper in the 'Leeds Mercury' of the 23rd of February last, on the Fever Haunts of Leeds. Without following the author of this paper from court to court, from one den of filth to another, we knew that such things were taking place. It may be very well for the pious church and chapel-going and missionary-society subscribing people of Leeds to say they had no idea such abominations existed. For years Leeds has had its tell-tale, and those who are at a distance have had their eyes upon it. That tell-tale is the bill of mortality, and we find by it that month after month and year after year, and long before its awful mortality attracted the attention of Government, that Leeds was a nest of dirt and filth and neglect. The details of Dr. Hunter's Report, in January, 1866, were so terrible—so unutterably disgusting, that

everyone expected that some active measures would have been immediately taken by the inhabitants (for it is sheer nonsense to attribute this neglect to corporations) to remove the evils then exposed. But here at the end of twelve months we find the same sickening account of accumulated filth—of pale-faced, hollow-eyed children—of strong men and women dying of fever; in short, English people giving indications of an existence more degrading than anything Du Chaillu or Livingstone has described of the blacks of Africa. Are there no black-skins or red-skins in the world who will take pity on these poor whites, and send over some missionaries to help them, and try to convert the people of Leeds to Christianity?

We now turn to what is being done in some other towns in the United Kingdom.

Since the remarks were written which appeared in the October number of this Journal in reference to the sanitary condition of Glasgow, that city, in common with other populous places, has had its attack of epidemic cholera and diarrhœa. Compared with the results of that epidemic in some towns, and compared with the population of Glasgow and suburbs, well nigh 500,000, the number of cases and the mortality were small. The visitation, however, has taught some valuable lessons which will not be without effect in the proper quarter. Owing to the existence of a well-qualified sanitary staff, presided over by Dr. W. T. Gairdner and the other medical officers, all of whom were thoroughly alive to the work required of them, and owing, likewise, to the extensive powers vested in the police authorities by the Local Police Act (1866), such provision was made to meet the attack of the conjoined epidemics, that they seem almost to have been frightened away from a city where, on former occasions, they produced dreadful ravages. Very few cases were reported during the months of August and September, and for the three months beginning with October, the following numbers give the total cases and deaths:—

	Cases.	Deaths.
Cholera	45	35
Choleraic Diarrhœa	65	9
Diarrhœa	621	74
Totals . . .	731	118

Besides employing a portion of the Police Fever Hospital formerly spoken of for the patients, a special cholera hospital was erected on Glasgow Green, and amply and suitably furnished at considerable expense. The latter is now closed up—its "occupation 's gone," but the former is in much request for fever patients, typhus having greatly increased, owing probably, in part, to the poverty and wretchedness which great depression in trade has brought about among the poor; indeed, the death rate is now (February) higher

than it was during the cholera epidemic. An excellent and complete system of house to house visitation was commenced in the autumn, and is still continued, and to this, as also to the ample supply of Loch Katrine water—probably unsurpassed for quality and quantity either in ancient or modern times—may be attributed the comparative immunity from cholera which Glasgow enjoyed during the recent visitation. *There is no well or pump water used in Glasgow.*

The police authorities, by means of the night part of the force, are still continuing to inspect the houses of less than three apartments, so as to prevent overcrowding, one of the most fruitful causes of epidemic disease. The following table gives the results of the inspection up to, and including, the quarters ending:—

	Houses visited.	Found overcrowded.	Found empty.	Found not overcrowded.
31st October, 1866 . . .	18,208	1,814	328	16,066
31st January, 1867 . . .	20,249	1,679	314	18,256

As regards the sewerage of Glasgow, it may be stated that things are rapidly ripening for action, which must result in measures not yielding in importance to the emptying of the contents of the Highland Loch into the cisterns and baths of the Glasgow citizens, or the scheme for remodelling the streets and other thoroughfares under the City Improvement Act, at an expense of a million and a quarter sterling. The town council was represented in the late Leamington Congress, one of the deputation being Mr. Walter Macfarlane, the manufacturer of the well-known patented sanitary appliances. The Clyde trustees mean action also, as they feel indisposed to submit passively to the great injury which the sewage discharged into the river is effecting upon the shipping, in which most of them are interested; a comprehensive scheme, therefore, for diverting the sewage from the Clyde is not an improbable thing, and seems actually to be "looming" in the near future.

With regard to the health of Liverpool, it is now well known that Mr. Arnold Taylor, of the Local Government Office, visited Liverpool last autumn, to inquire into the system of defecation practised there, and that in his report he was compelled to refer to other causes the high rate of mortality in Liverpool. He drew attention to the imperfect water-supply and the badly constructed houses, as well as to the wretched midden system, and in consequence of his report, the Corporation were requested to discontinue the practice of depositing night-soil on a certain wharf in the heart of the fever district, and to give guarantees that the use of the wharf would be discontinued, except for the shipment of innocuous substances.

The town council, after making haste to comply with a portion of the order, at the instigation of their Health Committee denied the legality of the inquiry, and declined to give the requisite guarantee, lecturing the Home Secretary in a somewhat amusing manner upon his course of proceeding, and saying that the Sanitary Act was not intended for such an influential body of gentlemen as they are. The Sanitary Association of the town, however, supplemented the "reply" of the mayor by further information on the sanitary state of the town, and on the 4th of March, Mr. B. Samuelson, M.P. for Banbury, asked the Home Secretary to publish Mr. Taylor's report, which applies to other towns besides Liverpool, and which the honourable member was asked for by the Sanitary Reform League recently established at Manchester.

Mr. Walpole spoke highly of Mr. Taylor's Report, which is a most admirable essay on the sanitary defects of Liverpool, and an account of many abuses existing not alone there, but also in most of our large towns, and promised to give the Report and correspondence his best consideration. Probably before these remarks go to press, some portion, if not the whole, of the Report will be issued, and we commend it to the notice of all sincere sanitary reformers.

The Liverpool Town Council is applying to Parliament for nearly a million sterling for town improvements, but so little of this money is to be expended for *bonâ fide* sanitary purposes, that it is to be hoped Parliament will consider well before the Bill is allowed to pass; and there is no doubt that, for the future, *all* such bills will be watched much more narrowly than has hitherto been the case.

In most cases where large sums are asked for by our boroughs for so-called "improvements," it may be taken for granted that a considerable proportion of the money required finds its way into the pockets of persons more or less intimately connected with the corporation, who have land or buildings which they wish to be rid of at a remunerative price. We expect shortly to hear more of these "jobs."

A description of the state of Manchester will be found in a separate article in this Number, as also some account of Mr. Torrens's Artizans' and Labourers' Dwellings Bill.

Quarterly List of Publications received for Review.

1. The World before the Deluge. By Louis Figuier. A new edition, the Geological portion carefully revised and much original matter added by Henry W. Bristow, F.R.S., containing 24 Full-page Illustrations of Extinct Animals and Ideal Landscapes of the Ancient World, designed by Riou; and 202 Figures of Animals, Plants, and other Fossil Remains and Restorations. *Chapman & Hall.*

2. The Vegetable World; being a History of Plants, with their Botanical Descriptions and Peculiar Properties. By Louis Figuier. Illustrated with 446 Engravings interspersed through the text, and 24 Full-page Illustrations, chiefly drawn from Nature, by M. Faguet, Illustrator to the Botanical Course of the Faculty of Sciences of Paris. *Chapman & Hall.*

3. Principles of Geology; or, The Modern Changes of the Earth and its Inhabitants considered as Illustrative of Geology. By Sir Charles Lyell, Bart., M.A., F.R.S. Tenth edition. Vol. I., with Maps, Plates, and Woodcuts. 680 pp. 8vo. *John Murray.*

4. Useful Information for Engineers. Third Series. By Wm. Fairbairn, C.E., LL.D., F.R.S., &c. *Longmans & Co.*

5. Familiar Lectures on Scientific Subjects. By Sir John W. F. Herschel, Bart., K.H. 510 pp. Fcap. 8vo. *Alexander Strahan.*

6. Descriptive Astronomy. By George F. Chambers, F.R.A.S. 224 Illustrations. 850 pp. 8vo. *Macmillan & Co.*

7. Lectures on Public Health, delivered at the Royal College of Surgeons. By E. D. Mapother, M.D., Professor of Hygiene, Medical Officer of Health, City of Dublin. Second edition. Engravings. 660 pp. Fcap. 8vo. *Dublin: Fannin & Co.*

8. Modern Arithmetic: A Treatise adapted for School Work and Private Study. By Rev. John Hunter, M.A., formerly Vice-Principal of the National Society's Training College, Battersea. 450 pp. 12mo. *Longmans, Green, & Co.*

9. Fecundity, Fertility, Sterility, and Allied Topics. By J. Matthews Duncan, A.M., M.D., Lecturer on Midwifery in Surgeons' Hall Medical School, Edinburgh. 380 pp. 8vo. *A. & C. Black.*

10. The Twin Records of Creation; or, Geology and Genesis: their Harmony and wonderful Concord. By Geo. W. Victor Le Vaux. With numerous Illustrations. 250 pp. Fcap. 8vo. *Lockwood & Co.*

11. A Journey to Ashango-Land: and further penetration into Equatorial Africa. By Paul B. du Chaillu. With Plates and Map. 500 pp. 8vo. *John Murray.*

12. Theoretical Astronomy, Examined and Exposed. By "Common Sense." 140 pp. 8vo. *Job Caudwell.*

13. L'Année Scientifique et Industrielle. Par Louis Figuier. *Paris: Hachette & Co.*

14. Les Merveilles de la Science, ou Description Populaire des Inventions Modernes. (*Numerous illustrations.*) *Paris: Furne, Jouvet & C^ie^.*

15. The Elements. An Investigation of the Forces which determine the Position and Movements of the Ocean and Atmosphere. By W. L. Jordan. Vol. XI. *Longmans & Co.*

16. Chemistry, Inorganic and Organic. With Experiments and a Comparison of Equivalent and Molecular Formulæ. By Charles Loudon Bloxam, Professor of Practical Chemistry in King's College, London. With 276 Wood Engravings. 700 pp. 8vo. *J. Churchill & Sons.*

17. Intercolonial Exhibition, 1866. Mining and Mineral Statistics. By R. Brough Smyth, F.G.S., Secretary of Mines for the Colony of Victoria. 40 pp. 8vo.

PAMPHLETS, PERIODICALS, PROCEEDINGS OF SOCIETIES, &c.

Classification of the Functions of the Human Body, and the Principles on which it rests. By Andrew Buchanan, M.D., Professor of Physiology in the University of Glasgow. 24 pp., 8vo. *J. Churchill & Sons.*

Sketch of the Mineralogy of Nova Scotia, as illustrated by the Collections of Minerals sent to the Paris Exhibition, 1867. By Professor How, D.C.L., University of King's College, Windsor, N.S. 6 pp. 8vo.

The Water Question; a Letter addressed (by permission) to the Right Hon. The Earl of Derby, K.G., &c., explaining a Proposal for the Supply of the Metropolis from the higher Source of the Thames in conjunction with the Storage of Surplus Waters. By J. Bailey Denton, C.E. *London: Stanford.*

Phases in the Developmental History of Infusorial Animal Life. By Jabez Hogg, M.R.C.S.

Tenth Annual Report of the Works executed by the Board of Works for the Whitechapel District. *From the Board.*

On Ozone. By Charles Daubeny, M.D., F.R.S. *From the Author.*

The Martindale Luminary. Broad Sheet. *From America.*

The Development of Science among Nations. By Baron Justus Liebig, F.R.S. 32 pp. Demy 8vo. *Edmonston & Douglas.*

On the Recent Suspension by the Board of Trade of Cautionary Storm Warnings. By Joseph Baxendell, F.R.A.S. 4½ pp. 8vo.

Matter: Its Ministry to Life in Health and Disease, and Earth as the Natural Link between Organic and Inorganic Matter. By Thomas Hawksley, M.D. Lond. *Churchill & Sons.*

Comparisons of the Icebergs of Belle-Isle, with the Glaciers of Mont Blanc, with Reference to the Boulder-Clay of Canada. By J. W. Dawson, LL.D., F.R.S., F.G.S., Principal of McGill College.

On the Conditions of the Deposition of Coal, more especially as Illustrated by the Coal Formation of Nova Scotia and New Brunswick. By J. W. Dawson, LL.D., F.R.S., &c.

The Evidence of Fossil Plants as to the Climate of the Post-pliocene Period in Canada. By J. W. Dawson, LL.D., F.R.S., &c.

Annual Report of the Miners' Association of Cornwall and Devonshire. By R. Hunt, F.R.S., Hon. Sec. *Truro: Heard & Sons.*

Notes for a History of Sanitary Legislation. By Edwin Lankester, M.D., F.R.S. *Chapman & Hall.*

The Fourth Annual Report of the Coroner for the Central District of Middlesex. From Aug. 1, 1865, to July 31, 1866. By Edwin Lankester, M.D., F.R.S.

The Artizans' and Labourers' Dwellings Bill.

The Annual Report of the Improved Labourers' Dwellings Society.

The Glacial Period in North America. By Thomas Belt, F.G.S.

Revue Universelle des Mines, de la Métallurgie, &c. Bureaux; Paris, Rue St-Dominique-St-Germain, n° 11; Liége, Place St-Paul, n° 6.

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation. *Paris: Masson.*

Journal de Médecine Mentale. *Paris: Masson.*

Le Mouvement Médical, Journal de Santé Publique. M. V. Groupy, 5, Rue Garancière.

The Westminster Review.

The Geological Magazine.

Proceedings of the Royal Society.
" " Royal Astronomical Society.
" " Royal Geographical Society.
" " Chemical Society.
" " Geological Society.
" " Zoological Society.

TO CORRESPONDENTS.

The Editors will be glad to receive the Printed Proceedings of Local Boards of Health, and of other Sanitary Corporations, to which due consideration will be given by the Editor of the Quarterly Article on the Public Health.

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